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I. THE WATER SUPPLY OF LONDON, AND THE CHOLERA.

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The growth of nearly every large town has involved a succession of struggles for the supply of its inhabitants with pure water. Even the aggregation of a few houses forming a village not unfrequently causes a sensible pollution of the water supply, if the wells be sufficiently shallow. As the village develops into a town, the water from such sources not only becomes dangerous from impurity, but also totally insufficient in quantity for the increasing population. Recourse is then had to a neighbouring stream for a purer and more copious supply; but greater abundance of the useful liquid determines the production of a larger volume of sewage, part of which, as the town extends itself along the banks of the stream, begins to be discharged above the point at which the water supply is withdrawn. Contamination again ensues, and the place of withdrawal is removed higher up the river. Relief is thus obtained, but it is only temporary; villages nearer the source of the stream grow into small towns, and the struggle is only terminated by seizing upon and impounding the very sources of the stream itself, by which alone a permanently wholesome and untainted beverage can be secured. Such is the history of water supply in most large towns, and such is, or must be, its history in the English capital. Another visitation of the most terrible epidemic to which modern London is still subject has once more called earnest attention to the serious defects of the metropolitan water supply. It will require much acute observation and laborious experimental research before the origin and spread of cholera will be thoroughly understood; but there are certain prominent features in the character of this epidemic which at once arrest attention and at least suggest the direction in

which further inquiry would probably lead to discovery. In the first place we find cholera making its appearance in various localities, healthy or otherwise, and frequently without any apparent cause. Such sporadic attacks occur equally in large towns and in isolated hamlets; as a rule, they carry off the first victim and one or two of his friends or neighbours, whose contact, either direct or indirect, with his dejections can frequently be traced. The disease, however, does not spread farther, but soon becomes extinct, to break out again perhaps in a similar manner after the lapse of weeks or months. In this way, isolated attacks were continually occurring during the summer and autumn of 1866 in Manchester and Birmingham, as well as in scores of small villages and isolated hamlets scattered throughout the whole United Kingdom. Such irregular and sporadic assaults powerfully suggest the presence of a specific poison in the atmosphere suspended as impalpable spores or germs, not therefore obeying the law of the diffusion of gases, but depending upon currents of air for their transport from place to place; in fact, behaving exactly like the spores of green mould or those of the fungus known to gardeners as *damp*, both of which have so completely taken possession of our atmosphere, that there is probably not a cubic foot of air near the earth's surface which does not contain numbers of them. But these germs, though present everywhere, cannot grow and reproduce themselves except under certain favourable conditions. Place a piece of calf's-foot jelly in a dry atmosphere and it will not become mouldy, but a few hours' sojourn in a damp closet will infallibly cover it with a perfect forest of vegetation. Again, let a geranium be placed in the open air or in a well-ventilated and well-lighted conservatory, and its leaves and stems will continue green and healthy, but let either the light or ventilation be bad, and the plant "damps," that is, it becomes covered with a fungus which rapidly destroys its vitality. Thus both kinds of vegetable spores are incapable of vivification without certain favourable conditions, which are moreover peculiar for each description of organism.

The cholera poison, if present in the atmosphere, doubtless also requires a favourable conjunction of conditions to render its development possible. If one of these conditions be absent, the concurrence of all the others is insufficient to produce the effect. Thus, it is highly probable that in the case of cholera, as in that of other epidemic diseases, there are many individuals who, during the time of the epidemic at least, are in such a condition of body as to be absolutely incapable of taking the disease, even if every other favourable circumstance be present. But besides the bodily capacity for the effective reception of the cholera germ, there appears to be in most, probably in all, cases, one other condition at least necessary. This condition may be supplied in food and drink. A young

girl in the little village of Farrington, in Lancashire, eats a quarter of a peck of green apples; within twelve hours she is seized with cholera and dies. Another girl does precisely the same thing in Pimlico, and a like result follows. Such are the causes of the so-called sporadic cases of cholera. It is scarcely conceivable that the cholera poison was present in the apples more than in any other article of daily food, but the fruit supplied the only condition wanting to enable the poison to vivify and propagate itself in the system. Now if, during the prevalence of cholera, all the inhabitants of a town, or of one particular quarter of a town, were to eat daily this excessive amount of apples, can it be doubted that the disease would assume what is called its epidemic form, and would attack such of the fruit eaters as were unfortunate enough to be capable of vivifying and propagating the poison?

Communities do not, however, thus consume inordinate quantities of apples, or other fruit capable of affording a congenial soil for the cholera germ; but it is evident that if the necessary material were present in bread, milk, butter, or tea, the disease would at once assume its epidemic form throughout the country. Now of all materials which have been observed to determine an attack of cholera there is one which stands pre-eminent. Evidence of the most conclusive character from numerous independent and trustworthy sources points to one material as that best adapted, when introduced into the human stomach, to vivify and develop the cholera germ. This material is sewage. Whether sewage forms a congenial soil for the cholera spores supplied to it from the air or from cholera patients, and thus introduces those spores in an already vivified condition into the stomach, or whether it merely supplies the material for their growth and propagation in the intestines may be disputed, but, divested of all theory whatever, the fact still remains clear and incontrovertible that amongst the materials which, during the prevalence of the disease, produce cholera when taken internally, sewage is the most effective; and this property sewage preserves, although in a diminished degree, even when largely diluted. In the supply of a family with water contaminated with sewage, the necessary condition for the production of *sporadic cholera* is provided, and in the supply of such a water to a community we furnish the necessary condition for the establishment of *epidemic cholera.*

The history of cholera epidemics furnishes abundant evidence in support of both these propositions; I must content myself, however, by quoting the following cases. On the 18th day of August last a family from London went to reside at Upper Marine Terrace, Margate. On the evening of August 26th a heavy thunderstorm visited the town, and an unusually large quantity of rain fell. The hot water that was brought to the bedrooms the

next morning emitted a peculiar smell, and a glass of cold water was turbid and had an unpleasant taste. The water was supplied from a well at the bottom of the garden. During the ensuing night four of the inmates of the house were simultaneously attacked by choleraic diarrhœa, and during the following day several others. Two of those attacked during the night died on the evening of that day; their deaths are registered as caused by choleraic diarrhœa. The waiting boy, who was quite well at noon on that day, died of Asiatic cholera before midnight, and a lady died on the 1st of September following of the same disease. Three other inmates of the same house returned to St. John's Wood, London, immediately; but they were all attacked by Asiatic cholera: one of them died on the 1st of September, another two days later, whilst the third recovered.

A sample of the well-water used by the inmates of this house was taken on the 30th of August and sent to me for analysis. It contained 93·4 parts of solid matter in 100,000 parts; of this the very large amount of 7·36 parts consisted of organic and other volatile matter. There is a cesspool situated near to this well, and it can scarcely be doubted that, during the thunderstorm above mentioned, this cesspool overflowed into the well, causing the fatal contamination; for on analytically examining a sample of water collected from the same well on the 18th of September following, I found its character entirely changed. It now contained 82·75 parts of solid impurity in 100,000 parts of water, and of these only 1·13 part was organic or other volatile matter. It was clearly ascertained that the water of this well was drunk by all those attacked.*

Such is the history of the sporadic outbreak of the disease, costing six lives. Dr. Lankester, in his article on the public health in the January number of this Journal, mentions a parallel case which occurred in Epping Forest and resulted in the death of eight persons. Here again it was clearly proved that the overflow from a cesspool passed directly into the well from which the household derived their supply of water. The celebrated case of the Broad-street pump, which in 1854 caused the terrible outbreak of cholera in the parish of St. James, Westminster, forms as it were a connecting link between the above sporadic explosions and the gigantic epidemics which devastated London in 1849, 1854, and 1866. Dr. Farr has conclusively shown, not only that these epidemics were directly connected with the supply of water contaminated with sewage, but also that the violence of the epidemic depended upon the degree of contamination of the water supply. Thus it was shown that, in the visitation of 1849, that portion of

* For further particulars of this case, see the supplement of the weekly return of the Registrar-General for the week ending 24th November, 1866.

the metropolitan population which was supplied by water taken from the Thames, at Kew, suffered a mortality from cholera of 8 in 10,000. Of every 10,000 people supplied with water taken from the river at Hammersmith, 17 died. Of the inhabitants of Belgravia, St. George's, Hanover-square, Chelsea, and Westminster, supplied with water taken below Chelsea Hospital, 47 in 10,000 died. Whilst the populations drawing their supply still lower down, *viz.* at Battersea, and between Hungerford and Waterloo bridges, where the river was still more foul, suffered to the extent of 163 in 10,000. In the year 1854 one-half of this latter district was supplied by water taken above Teddington Lock, and the deaths fell to 87—little more than one-half; whilst last year, when the whole supply was drawn above Teddington Lock, the loss of life from cholera was only 8 in 10,000. Again Manchester, which is in other respects one of the most unhealthy cities in the United Kingdom, furnishes remarkable evidence that cholera can never establish itself as an epidemic unless the water supply of a community be tainted with organic impurity; this city suffered fearfully from cholera in 1832 and 1849 whilst supplied with impure water, but after the introduction of pure water from the Derbyshire hills, the return of the disease in 1854, and again last year, manifested itself in Manchester by a few sporadic cases only.

All the water withdrawn from the Thames for the supply of London is now taken above Teddington Lock, and its filtration before distribution is rendered compulsory by the Metropolitan Water Act of 1852. The wisdom of thus taking the water at a higher point and of enforcing its filtration is evidenced by the comparative slight mortality from cholera last year in those districts supplied with Thames water. Far different, according to the returns of the Registrar-General, was the fate of that portion of the metropolis which had the misfortune to be supplied from reservoirs at Old Ford, belonging to the East London Water Company. The suddenness and virulence of the outbreak of cholera in the east of London last summer at once aroused the suspicions of the Registrar-General, who requested me to make an immediate investigation into the East London Water Company's supply. I found the chief reservoir at Old Ford to be situated close to the river Lea, which is there little better than an open sewer. This reservoir is also sunk 16 feet beneath the low ground, which is there only just above the level of spring tides; consequently the water in the reservoir is always below Trinity high-water mark. It was evident that soakage from the adjacent foul river and from the surrounding soil, saturated as it was with sewage, must take place into such an excavation with its floor of two and a half acres in extent, and this has since been confirmed by recent investigation when this reservoir was emptied as far as possible by pumping. The foreman at the

Old Ford Water Works has also since admitted that he distributed *unfiltered* water from one of these reservoirs a few days previous to the cholera outbreak. The mortality in that portion of London supplied from the Old Ford reservoirs was frightful, for whilst the deaths in the districts drawing water from other sources varied from 2 to 12 in 10,000, they ranged from 63 to 111 in 10,000 in those districts supplied from these reservoirs.

London is at present supplied with water by nine companies, who deliver about 108,000,000 gallons daily. A better idea may be formed of the vastness of this supply by a comparison of its volume with some well-known magnitude. If it were contained in a reservoir having a floor-area equal to that of Westminster Hall, the walls would require to be carried to the height of 1,070 feet, or more than three times the height of the Victoria tower, to enable it to contain the water which is daily distributed in the metropolis. Five of the water companies abstract about one-half of the total supply from the Thames; two withdraw about 42,000,000 gallons from the river Lea, and the remainder is pumped by two other companies (the Kent and South Essex Companies) from Artesian wells sunk into the chalk of the Thames basin. Such is the present volume of water daily supplied to London and its suburbs; what will be the amount required twenty years hence, it is difficult to estimate, but if the annual rate of increase since 1850 be continued, it can scarcely be less than 150,000,000 of gallons; for in 1850 the gross daily quantity delivered was only 44½ millions of gallons, in 1856 it had reached 81,000,000 gallons, whilst in 1865 it was 108,000,000 gallons.

Notwithstanding the best efforts of the water companies, the present supply of water to the metropolis is far from satisfactory, owing to causes which are mostly beyond the control of those to whom that supply is entrusted; it is therefore contemplated either to change entirely the source, and thus obtain water of greater purity than any available in the neighbourhood of London, or so to alter the conditions at present affecting Thames water as to materially improve its quality. For this purpose no less than five schemes have been recently brought forward, *viz.*:—

1. Sources of the Severn, proposed by Mr. Bateman.
2. The Cumberland Lakes—Messrs. Hemans and Hassard.
3. Thames water filtered through Bagshot Sands—Mr. Telford Macneill.
4. Storage reservoirs near the sources of the Thames—Mr. Bailey Denton.
5. Derbyshire and Staffordshire hills—Mr. Remington.

The first two of these schemes have been recently so ably discussed in this Journal by Mr. Edward Hull, that it will be only necessary here to allude to the chemical quality of the water; the

remaining three schemes have not yet been sufficiently matured to permit of their treatment from a chemical point of view. The first two colossal schemes are truly worthy of this age of engineering triumphs, and of the great city on behalf of which they are projected. Before the advantages of such magnificent undertakings can be appreciated, however, it is necessary first to consider the chemical quality of our present supply, and then to compare it with that of the water which the new sources are capable of furnishing.

The impurities present, or liable to be present, in the waters supplied to the metropolis may be thus classified:—

Innocuous.	Soap destroying.	Previous sewage contamination.	Present sewage contamination.
Common salt.	Salts of lime and magnesia.	Nitrates, nitrites, and ammonia.	Nitrogenous organic matter.

The most important things to be ascertained respecting the impurities in water used for domestic purposes are—first, the amount of sewage contamination previous and present; and secondly, the quantity of soap-destroying materials. The organic matters, containing nitrogen which occur dissolved in water, are chiefly, if not entirely, of animal origin, being derived either from sewage or manured land; be their origin, however, animal or vegetable, no distinction founded upon their source can be drawn between their respective noxious qualities. After admixture with spring or river water, these noxious organic matters undergo slow oxidation, by which they are finally resolved into comparatively innocuous mineral compounds; their carbon is converted into carbonic acid gas, and their hydrogen into water, and these products can no longer be identified in the aërated waters of the river or spring; but the nitrogen is converted into nitrous and nitric acids, which, combining with the bases contained in most waters, remain dissolved, and constitute a record of the sewage or other analogous contamination to which the water has been subject. With certain corrections presently to be mentioned, the analytical determination of the nitrogen contained in these salts and in the form of ammonia writes, as it were, the history of the water, as regards its contact with decomposing animal matter. Such previous organic contamination may be conveniently expressed in parts of average filtered London sewage, which, if thus completely oxidized in a river, would yield a like amount of nitrogen, in the form of nitrites, nitrates, and ammonia. For this purpose, average filtered London sewage may be taken as containing ten parts of combined nitrogen in 100,000 parts, as deduced from the numerous analyses of Way, Hofmann, and Witt. The number so obtained as the *previous sewage contamination* of a water requires, however, a correction, since rain-water itself contains combined nitrogen in the forms of ammonia, nitrite of ammonia, and nitrate

of ammonia. The amount of these substances present in rain which falls at Rothampstead has been most carefully determined by a laborious series of monthly analyses, made independently on the one hand by Messrs. Lawes and Gilbert, and on the other by Professor Way, and extending over two years. The results of these chemists accord well, and they give as the average amount of nitrogen in the forms of ammonia, nitrite of ammonia, and nitrate of ammonia, ·0985 parts in 100,000 parts of rain-water. This must be deducted therefore from the calculated amount of previous sewage contamination of any sample of water. It corresponds to 985 parts of previous sewage contamination in 100,000 parts of the water. There is no doubt that this reduction is too large, and therefore favourable to the character of the water, since in most cases but a very small proportion of the water of a river or spring falls as rain directly into the stream; and Professor Way has proved that almost every trace of the ammonia contained in rain-water is absorbed when the water percolates through cultivated soils. Now, as three-fourths of the combined nitrogen in rain-water is in the form of ammonia, it is evident that rain-water must be deprived of much of its original nitrogenous contamination before it reaches such a river as the Thames. The very small amount of combined nitrogen found in natural waters of undoubted purity, such as that of Loch Katrine for instance, also testifies to the liberality of the above allowance. The water of Loch Katrine contains only one-third as much combined nitrogen as that present in the rain falling at Rothampstead, so that, starting from the base line of purity above proposed, the water of Loch Katrine exhibits a *negative* previous sewage contamination equal to 575 parts in 100,000; or, in other words, it would require 575 parts of average London sewage to be added to, and allowed to oxidize in each 100,000 parts of Loch Katrine water before the purity of the latter would be reduced to the standard with which I propose to compare the metropolitan waters. It is necessary here to remark, however, that owing to the more copious rains of the Highlands of Scotland, the rain-water of that district probably contains less combined nitrogen than that which falls at Rothampstead. The following table exhibits the amount of total solid impurity contained in 100,000 parts of the metropolitan waters in the months of February and April last; it also shows the amount of carbon contained in the organic matter forming part of that solid impurity; the amount of nitrogen in the salts of nitrous and nitric acids; the quantity of ammonia, and finally the amount of previous sewage contamination. For the purpose of comparison the results yielded by Loch Katrine water as supplied to Glasgow in February last are appended.

Quality of the Waters supplied to the Metropolis during the Months of February and April, 1867.

1. Names of Companies.	2. Total solid Impurity in 100,000 parts of Water.		3. Organic Carbon.		4. Nitrogen as Nitrates and Nitrites		5. Ammonia.		6. Previous Sewage Contamination.	
	Feb.	April.	Feb.	April.	Feb.	April.	Feb.	April.	Feb.	April.
THAMES.										
Chelsea	28·58	27 86	·433	·267	·337	·267	·004	·002	2420	2195
West Middlesex	28·68	28 06	340	·224	·356	·269	·006	·004	2630	2245
Southwark and Vauxhall	29·08	28·52	·293	·166	·357	·298	·005	·002	2630	1945
Grand Junction	29·44	28·20	·417	·218	·322	·248	·004	·004	2270	2115
Lambeth	29·36	28·68	·423	·164	·341	·290	·005	·004	2470	2635
OTHER SOURCES.										
New River	29·72	26·44	·272	·273	·350	·274	·003	·002	2540	3155
East London	33·56	27·82	·293	·382	·357	·264	·004	·010	2620	2295
Kent	39·84	40·12	·088	·131	·421	·409	·008	·002	3300	2155
South Essex	38·32	—	·143	—	·844	—	·007	—	7520	—
Water from Loch Katrine as supplied in Glasgow	3·28	—	·256	—	·031	—	·002	—	0	—

This table is to be read in the following manner:—100,000 lbs. of the Chelsea Company's water contained in the month of February last 28·58 lbs. of solid impurity: the organic matter constituting a portion of this impurity contained 0·433 lb. of carbon. This solid impurity also contained 0·337 lb. of nitrogen in the form of nitrates and nitrites, besides 0·004 lb. of ammonia. The above quantity of water as supplied by the Chelsea Company had been, after its descent to the earth as rain, contaminated with sewage or the manure of cultivated land equivalent to 2,420 lbs. of average London sewage. By gradual oxidation, partly in the pores in the soil, partly in the Thames and its tributaries, and partly in the reservoirs, filters, and conduits of the Chelsea Water Company, this sewage contamination had been entirely converted into comparatively innocuous inorganic compounds before its delivery to consumers.

A glance at the table shows how vastly superior is the quality of the water of Loch Katrine as compared with that of the best at present supplied to London. 100,000 lbs. of this water contain but 3·28 lbs. of solid impurity, of which only 0·031 lb. is nitrogen in the form of nitrates and nitrites, and 0·002 lb. of ammonia. Further, Loch Katrine water exhibits no sewage contamination, either previous or present.

The nitrogenous organic matter which has escaped the process of oxidation above described, and which therefore still exists in the water at the time the analysis is made, constitutes what may be appropriately termed the *present sewage contamination* of the water.

The amount of this contamination may be expressed by the number of parts of average filtered London sewage (of the strength above described), which, if contained in 100,000 parts of pure water, would contaminate the latter with the same amount of combined nitrogen. No contamination of this nature has yet been detected in the waters supplied to the metropolis, but the investigations for its discovery have only been made since February last. It will doubtless be consolatory to the consumers of Thames water to know that, although, according to Mr. Bateman, the population within the basin of the Thames above the points at which the water is withdrawn for the supply of London exceeds 1,000,000 persons, the drainage of some 600,000 of whom is poured into the river, the whole of this fæcal matter is so completely oxidized before it reaches the water-cisterns of London as to defy the detection of any trace in its noxious or unoxidized condition. If the average flow of Thames water just above the point at which the London Companies withdraw their supply be taken at 800,000,000 of gallons daily, the drainage of 600,000 people ought to produce a sewage contamination of 2,250 parts in 100,000. It could scarcely be expected that this calculated number should approximate very closely to that obtained by the actual analysis of Thames water, since the calculated number depends upon many contingencies, as for instance, upon the volume of water actually flowing past the points of withdrawal at the time the companies abstracted the water analyzed; and secondly, upon the greater or less retention of the fæcal matters, in the sewers of the towns draining into the river. It is interesting, however, to find that the sewage contamination of Thames water, as determined by analysis, does not differ much from that calculated according to the above data. The analytical table given above shows that the average previous sewage contamination of the water delivered by the five companies drawing their supply from the Thames during the months of February and April, 1867, was 2,355 parts in 100,000 of water, the amount calculated from the number of persons draining into the river being, as just mentioned, 2,250 parts in 100,000 of water. As summer advances and aquatic vegetation becomes vigorous in the bed of the Thames and its tributaries, this coincidence of calculated and analytical results will probably be disturbed, as the water-plants can scarcely fail to withdraw an appreciable amount of nitrates and nitrites from the water, thus diminishing the quantity of combined nitrogen and consequently of previous sewage contamination as determined by analysis.

The second important class of impurities contained in water used for domestic purposes consists of certain mineral salts which possess the power of decomposing soap. These substances are the hardening or soap-destroying constituents of water. From a purely sanitary point of view they are of less direct importance than the

organic impurities; still, by rendering efficient ablution and thorough cleanliness difficult of obtainment, they doubtless indirectly affect the health of communities supplied with waters in which they are present in considerable quantities.

The chief hardening ingredients in potable waters are the salts of lime and magnesia. These salts decompose soap; forming curdy and insoluble compounds containing the fatty acids of the soap and the lime and magnesia of the salts. So long as this decomposition goes on the soap fails to produce a frothiness in the water, but when all the lime and magnesia salts have been decomposed by the action of the soap, the slightest further addition of the latter produces a lather when the water is agitated; but this lather is again destroyed by the addition of a further quantity of the hard water. Thus, the addition of hard water to a solution of soap—or the reverse of this operation—causes the production of the insoluble curdy matter above mentioned. Bearing this in mind, it is easy to understand the process of washing the skin with soap and hard water, which may be thus described:—First, the skin is wetted with the water, then soap is applied; the latter soon decomposes all the hardening salts contained in the small quantity of water with which the skin is covered, and there is then formed a strong solution of soap, which penetrates into the pores of the skin. This is the process which goes on whilst a lather is being produced in washing, but now the lather requires to be removed from the skin; how can this be done? Obviously only in one of two ways, *viz.* by wiping it off with a towel or by rinsing it away with water. In the former case, the pores of the skin are left filled with soap solution; in the latter, they become plugged up with the greasy curdy matter which results from the action of the hard water upon the soap solution occupying the pores of the cuticle. As the latter process of removing the lather is the one universally adopted, the operation of washing with soap and hard water is perfectly analogous to that used by the dyer or calico printer when he wishes to fix a pigment in the pores of any tissue. He first introduces into the tubes of the fibre of calico, for instance, a liquid containing one of the ingredients necessary for the formation of the insoluble pigment, this is followed by another liquid containing the remaining necessary ingredients, the insoluble pigment is then produced within the very tubes of the cotton fibre, and is thus imprisoned in such a manner as to defy removal by subsequent washing. The process of ablution, therefore, in hard water is essentially one of dyeing the skin with the white insoluble greasy and curdy salts of the fatty acids contained in soap. The pores of the skin are thus blocked up, and it is only because the insoluble pigment produced is white that such a repulsive operation is tolerated. To those, however, who have been accustomed to wash in soft water, the

abnormal condition of the skin thus induced is for a long time extremely unpleasant.

Nevertheless, opinion is not quite unanimous as to the advantages of soft water over hard. Some persons consider hard water to be necessary for the supply of the calcareous matter of the bones, others believe soft water to be peculiarly liable to attack and dissolve the lead of the pipes through which it is conveyed, or of the cisterns in which it is stored.

An examination of the grounds upon which these opinions are based would completely refute them, but the limits of this article do not permit of such a digression, and I must therefore content myself with a mere allusion to one or two facts in connection with them. First, as to the necessity of hard water for the supply of the calcareous matter of bones. If it be assumed that a man drinks daily half a gallon of Thames water, he obtains from it $3\frac{3}{4}$ grains of lime chiefly in the form of chalk. This amounts to not quite 3 oz. per annum, which does not seem to be a very large contribution to bony matter. Now suppose the use of this water to be discontinued and that no part of it is replaced by bitter beer, which always contains far more lime in a given volume than Thames water; but we will assume that the individual consumes one-third of a pint of milk per day, he then receives in this quantity of milk more lime than his system can acquire from two quarts of Thames water. Then, as to soft water attacking and dissolving lead; it is by no means true, as a general proposition, that soft water does attack and dissolve this metal. The very soft water of Loch Ness, as supplied to Inverness, does not attack lead, as evidenced by the unimpaired condition of lead pipes through which that water flowed for six years: neither does the soft water of Ennerdale Lake, supplied to Whitehaven, attack lead. Even those soft waters which do attack the metal, such as those now supplied to Glasgow and Manchester, only do so when the surface of the lead is clean and bright. The action soon ceases, in fact as soon as the metal becomes tarnished the pipes are protected, and no complaints of any symptoms of lead poisoning have for the past ten years been heard from these large cities. Lastly, a sample of very soft water taken from one of the principal streams from which it is proposed to supply London has no action even upon clean and bright lead. Notwithstanding the numerous researches made in connection with this subject, the causes of the attack of lead by water have not yet been completely elucidated; it has, however, been established that the presence of oxygen and the comparative absence of carbonic acid in the dissolved gases are essential conditions to this action. Messrs. Graham, Miller, and Hofmann, in their report on the Metropolitan Waters in 1851, first showed that carbonic acid when dissolved in water was a complete protection against lead contamination, and from a series of experiments

recently made I find that 2 volumes of carbonic acid dissolved in 100 volumes of water completely protect even distilled water from such contamination. Rain water as it descends to the earth dissolves atmospheric gases, and this solution is afterwards continued in brooks and rivers. Of the chief atmospheric gases, carbonic acid is by far the most soluble, 100 volumes of pure water can dissolve 100 volumes of this gas; oxygen, on the other hand, only dissolves to the extent of 3 volumes in 100 volumes of water. Nevertheless, owing to the much larger proportion of oxygen than of carbonic acid in atmospheric air (500 : 1), water takes up oxygen more rapidly than carbonic acid, and hence freshly fallen rain-water acts upon lead; but when the water flows a great distance through an open conduit, the carbonic acid absorbed finally reaches the protecting proportion, and the action upon lead ceases, although the water retains its original softness. Hence there is no necessary connection between soft water and lead corrosion. Even distilled water left in contact with the air for some time loses its property of acting upon lead.

The hardness of a water is expressed in parts of carbonate of lime, or of its equivalent of other hardening salts, contained in 100,000 parts of the water, and each part of carbonate of lime contained in this quantity of water is generally termed a degree of hardness. This quality of the water may also be more popularly though less accurately expressed by the number of parts of soap destroyed or wasted by 100,000 parts of the water when used for washing purposes. Each degree of hardness indicates the destruction of 12 parts of the best hard soap by 100,000 parts of water. The following table shows the hardness of the London and Loch Katrine waters, according to both these methods of expression:—

Names of Companies.	Hardness.		Soap Destroyed.	
	February.	April.	February.	April.
Thames.				
Chelsea	16·2	17·7	194·4	212·4
West Middlesex . .	16·2	16·3	194·4	195·6
Southwark & Vauxhall	16·8	17·7	201·6	212·4
Grand Junction . .	17·1	17·7	205·2	212·4
Lambeth	16·0	17·7	192·0	212·4
Other Sources.				
New River	18·5	16·3	222·0	195·6
East London . . .	18·8	16·0	225·6	192·0
Kent	23·1	21·1	277·2	253·2
South Essex . . .	21·1	—	253·2	—
Water from Loch Katrine as supplied in Glasgow	·3	• —	3·6	—

According to this table, the Chelsea company's water possessed, in February last 16·2 degrees of hardness, and 100,000 lbs. of it, when used for washing, destroyed or wasted 194·4 lbs. of soap; whilst Loch Katrine water had only 0·3 degree of hardness, and 100,000 lbs. of this water destroyed only 3·6 lbs. of soap before the detergent action of the latter came into play. Such is the chemical history of the water at present supplied to the metropolis, and it must be borne in mind that, grave as are its defects, the mode of delivery of this water to consumers is still more defective. That in a densely populated city, water should be delivered only once, and for a few minutes, in twenty-four hours, and not at all on Sundays, is a condition of things utterly incompatible with the supply of wholesome and palatable water. Even if the water of Loch Katrine itself were delivered in London, according to the system at present adopted by the metropolitan water companies, it would infallibly be rendered unfit for human consumption after twenty-four hours' exposure to the vile atmosphere and sewer gases in which the water cisterns of London are systematically placed.

The fundamental defects of our present water supply may be thus summed up:—

1. Great previous sewage contamination.
2. Liability to present sewage contamination.
3. Great hardness.
4. Intermittent supply.

The waters from the sources of the Severn, and from the Cumberland lakes have not yet been submitted to the process of investigation above indicated, and it is therefore impossible to compare them in all respects with the present metropolitan supply. The water of the Bala Lake, in North Wales, which may be regarded as similar to that which would be supplied by Mr. Bateman's scheme, was examined by the late Dr. R. D. Thomson, and the waters of the Cumberland lakes have been more elaborately investigated by Professor Way. From the analyses of these chemists the following numbers are calculated:—

	Total solid impurity in 100,000 parts.	Hardness.	Soap destroyed.
Bala Lake . .	2·97	1°·1	13·2
Hawes Water .	5·70	2°·9	34·8
Ullswater . .	5·94	3°·0	36·0
Thirlmere . .	5·16	2 ·1	25·2

A comparison of these numbers with those given in the previous tables exhibits the great superiority of the proposed waters over those at present supplied to London, as regards total solid impurity and soap destroying ingredients; whilst it can scarcely be doubted

that water obtained from such sources will be as free from deleterious organic contamination as that of Loch Katrine.

In the event of a new source of water supply being at once determined upon, at least seven years must elapse before it can be rendered available to the metropolis; it therefore becomes important to inquire how far it is possible in the interim to ameliorate our present supply. The first and most obvious improvement would be the substitution of the *constant* for the *intermittent* system of delivery. With certain restrictions, all the metropolitan companies express their willingness to make this change, and with the unanimity of opinion regarding its advisability, it is difficult to account for the delay in effecting it, unless it arise from the paltry cost involved in the alteration of present fittings, which would fall upon the landlords of small tenements. Most towns of importance in Great Britain have been long supplied with water on the constant system; why then is this boon denied to London, where it is much more urgently required? Until this alteration is effected it is, for the bulk of the population, almost useless to improve the quality of the water. Where a supply for one or even two days has to be stored in a filthy butt, exposed to the foul atmosphere of a crowded court or alley, good and wholesome water can never reach the lips of the consumers.

The most formidable danger arising from the use of the present water supply is undoubtedly the liability to actual sewage contamination such as that which there is every reason to believe destroyed so many lives in the East of London last summer. The fearful import of such contamination is most graphically described by Dr. Farr, in the report of the Registrar General for the week ending July 28th, 1866. It is greatly to be wished that these reports which contain the weekly results of the great hygienic reactions of the community were more generally studied by the public, and especially by those who watch over the public health. It would be difficult, if not impossible, to find in the same space matter of greater or more immediate importance to a civilized nation, and it scarcely admits of doubt that by the prompt action rendered possible by these reports, thousands of lives were saved last summer in the metropolis alone. Describing what he saw in one of his visits to the East of London during the height of the cholera epidemic, Dr. Farr says:—"The mortality is overwhelming in some of the districts. In Poplar alone, 145; in Bow, 188 people died last week, including Dr. Ansell, the meritorious health officer, and Mr. Seeley, clerk to the Board of Works, whose name figures on the placards. The people are falling ill every hour; you see them of all ages, children and adults, lying about their beds like people under the influence of a deadly poison; some acutely suffering, nearly all conscious of their fate and of all that is going on around them. Here

the doctor is drawn in by the husband to see the wife now attacked; there the husband lies in spasms; here is an old woman seated dead with eyes wide open; there lies a fine four-year old child, his curly head drooping in death, but his mother says the pulse is strong and he takes what she gives him. An older brother just recovered is running about. Several wards of the London Hospital are full of patients, many of them very young children, in all stages of the disease; some dying, some well again and playing. The medical men have no rest, and with the Health Officers are nobly doing their duty; brave men ready to lay down their lives for their patients. The people themselves are most patient, most willing to help each other, the women always in front, and none shrinking danger. There is no desertion of children, husbands, wives, fathers, or mothers from fear."

This picture of misery, traced with such a high degree of probability by eminent medical authorities to the sewage pollution of water, suggests the inquiry whether or not anything can be done with regard to our present water supply to prevent such frightful accidents in future. How can we best protect ourselves against this noxious contamination? The answer is, there is no absolutely reliable protection. Filtration through animal charcoal is perhaps the best safeguard, but I have shown that this process fails to remove from water the matter which is believed to constitute cholera poison. Permanganate of potash is also an excellent purifier of water, but there is not the slightest evidence that this agent can destroy cholera poison. Boiling the water for a short time is no guarantee that its noxious qualities are destroyed, for even on the very probable supposition that cholera and other similar poisons are organic germs, we know that many such germs, especially those which are of a low type, retain their vitality after being boiled in water, or even after exposure to a temperature of 248° F. for a considerable time. The late Dr. Lindley mentions the fact of raspberry seeds germinating after being boiled for jam, and as syrup boils at a higher temperature than water these seeds must have been exposed to a heat considerably higher than that of boiling water. Nearly twenty years ago a curious red fungus or mould (*Oidium aurantiacum*) attacked the bread of Paris. M. Payen exposed pieces of bread, upon which spores of the fungus had been sown, for half-an-hour to a temperature of 248° F. in tubes; the red fungus afterwards germinated, although its vitality was destroyed when the temperature was raised to 284° F. I have incontrovertible evidence of the production of violent cramps and diarrhœa by the drinking of tea made from water which, previous to boiling, had become contaminated with sewage.

Nevertheless, whilst none of these methods can be relied upon for the destruction of noxious organic matter in water, I am far

from wishing to discourage their use as measures of precaution. More especially would I recommend filtration through animal charcoal as a most undoubted and valuable means of greatly reducing the amount of organic matter in water. I find that water will readily pass through a stratum of animal charcoal three feet thick at the rate of 41,472 gallons per day per square foot, the oxidizable organic matter contained in the water being reduced to one half. Five hundred tons of animal charcoal would be an ample quantity through which thus to pass the whole of the present metropolitan water supply. This at 13*l.* per ton would cost 6,500*l.* The charcoal would require to be heated to redness in retorts or ovens for a couple of hours every six months. It would last for two years and would then be worth nearly half its original cost as manure.

With regard to the excessive hardness of the London waters, it does not appear that any practicable scheme of amelioration has yet been contrived. Some years ago a beautiful and very simple process of softening hard waters by the addition of lime was devised by Dr. Clark of Aberdeen; but although this process has repeatedly been tried by water companies, it has invariably been again abandoned, since, notwithstanding the cheapness of the material employed, the amount of carbonate of lime deposited by the London waters, when submitted to this treatment, was, in the case of such vast volumes of water, so enormous as to cause the process to be pronounced impracticable. It is to be feared therefore that we must for the present be content to block up the pores of our skins with the greasy curd of hard water, but it is very desirable that the other ameliorations of which I have spoken should be carried out at once, although they ought not to delay the introduction of a water supply free from sewage contamination, for until such a supply reaches the metropolis its inhabitants will continue liable to repetitions of the terrible slaughter which occurred last summer, from the effects of which the east of London has not even yet recovered.

II. MR. JUKES AND THE GEOLOGICAL SOCIETY.*

It not unfrequently happens amongst large bodies of men whose affairs are conducted by a committee, council, or directorate, that the action of the executive will occasionally be disapproved of by some one or more individuals, who may even feel personally injured

* 'Additional Notes on the Grouping of the Rocks of North Devon and West Somerset: with a Map and Section.' By J. Beete Jukes, M.A., F.R.S., &c. Preceded by an Introductory Statement. Printed for circulation among the Fellows of the Geological Society of London. Dublin: Webb & Son, 1867, pp. 37.

thereby. Such differences are not unknown amongst scientific societies, and we now propose to discuss one which has recently arisen between the council and a distinguished Fellow of one of the most prominent of the learned societies—the Geological Society of London.

On March 7th of last year, Mr. J. B. Jukes, local director of the Geological Survey of Ireland, read before the Geological Society a paper "On the Carboniferous Slate (or Devonian rocks) and the Old Red Sandstone of South Ireland and North Devon," which was published in due course in the Society's 'Quarterly Journal,'* occupying fifty closely printed octavo pages. In this paper the author endeavoured to prove two points:—(1) that the Devonian rocks of North Devon are synchronous with the Carboniferous Slate of Ireland; and (2) that "the Lynton beds are on the same general horizon as those of Baggy Point and Marwood," although "there appears to be a regular ascending succession of rock-groups from Lynton to the latitude of Barnstaple," which Mr. Jukes endeavoured to explain by the aid of a "concealed fault running nearly east and west through the centre of North Devon with a large downthrow to the north.† In this way he split up the great mass of Devonian rocks of North Devon into alternate zones of Carboniferous Slate and Old Red Sandstone (considered as distinct from Devonian).

Than this hypothesis it would be difficult to conceive a more startling heresy in British geology, and the reading of the paper was consequently followed by an animated debate, in which every speaker dissented from the view now for the first time expounded in England. Nevertheless the paper was published in full, for the idea was apparently new, and it is possible that future discoveries may lend it confirmation. Its author saw, however, that to convince his associates further evidence was necessary, and accordingly on the 7th of last November he read a second paper, the title of which is prefaced to this article. This paper, it appears, the council of the Society declined to publish, except in the form of an abstract without illustrations; and as this decision did not fall in with the views of the author, the council, at his request, returned to him his manuscript and illustrations, and published only the title of his paper in the 'Quarterly Journal.' Mr. Jukes has therefore printed his second paper as a pamphlet, prefacing it with some observations on the action of the council (at which he felt very much aggrieved), and on the history of the subject, and has sent a copy to every Fellow of the Geological Society.

Having thus placed our readers in possession of the essential facts, we can now discuss that part of Mr. Jukes's preface relating to the action of the council, in which he strikes at the fundamental

* *Op. cit.*, vol. xxii., No. 87, August, 1866, pp. 320–371.
† See also 'Quart. Journ. Science,' No. XII.

principle regulating the decisions of that body in regard to the publication of papers in the Society's journal.

We must begin by observing that whatever may have been the practice of the council in former days, when it required some vigilance to ensure that the papers should treat strictly of questions of fact—such being the object for which the Society was originally founded—does not now concern us; and our author's smart observations on the subject are altogether irrelevant, although it is perfectly possible that Mr. Warburton and others may have been at times unreasonably autocratic.

It will be as well if we now quote from Mr. Jukes, for the information of our readers, what takes place after a paper has been read before the Society:—

"The paper is, at the next meeting of the council, referred to some Fellow of the Society, who is supposed to have special knowledge of the subjects treated of, and he is requested to answer a printed list of questions which are sent with it. These questions, as well as I can recollect them, inquire whether there is anything personally offensive in the paper; whether there is anything superfluous, or absurd, or manifestly contrary to the principles of the science in it; whether it should be published *in extenso* or only in abstract; whether it should be accompanied with the illustrations, or whether any or all of the latter can be dispensed with; and generally, in fact, what is to be done with the paper.

"If the referee have the requisite knowledge, and acts with judgment and impartiality, and takes sufficient trouble to master the paper, of course the system would act in practice as well as it was meant to do theoretically."

Mr. Jukes further illustrates his position as follows:—

"I have two or three times acted as referee, and the plan I adopted was to treat it very much as a matter of form, just to look over the paper to see if there was anything in it personally offensive or disrespectful to any one; any obvious *lapsus calami* which the author would wish to have his attention called to; or anything manifestly childish, such as attempts to reconcile geology with the Mosaic cosmogony; and, if not, to recommend that it be printed as a matter of course."

According to these extracts the Society undertakes to print in their journal every paper accepted for reading, if it does not contain, in the opinion of the referee and the council, anything personally offensive, or superfluous, or absurd, or manifestly contrary to the principles of the science. If this be true Mr. Jukes has a right to complain, for it would seem, from the intrinsic evidence presented by his paper, that its rejection must rest on other grounds than these.

There is, however, a common saying that one tale is always good until another is told, and Mr. Jukes's tale would cer-

tainly have been good to all but a select few, had not a prominent member of the council of the Society (who avowed himself to be one of the referees) read to the assembled Fellows at a recent meeting the first question on the printed list to which Mr. Jukes has referred, as follows:—

"Is it desirable that the paper, as it stands, should be published in the 'Quarterly Journal of the Society,' as containing *new facts*, or *new views* of the bearing of *admitted facts*, or apparently well-founded *corrections* of important *errors* as to *matters of fact?*"

It must be admitted that this gives the matter a different complexion, and by the light of this information it seems fairly a question whether the council were not justified in refusing to print more than an abstract of the paper. Unfortunately for Mr. Jukes, he cannot plead ignorance of the stipulations to be complied with, as he owns to having two or three times acted as referee, and must therefore have had the questions addressed to him over and over again. That he did not discharge his duty more conscientiously is to be regretted in every way; had he done so, he would probably not have taken umbrage at the fate of his own paper. The proper course for him to have followed as referee, if he did not approve of the rules of the Society in respect to the publishing of papers, is manifestly, as was observed by his commentator, to have declined to act. Then, remembering his experience as referee he would probably not have selected the Society's journal as a medium for the publication of his papers on North Devon, although he would thus have deprived himself of the innocent excitement respecting his first paper, to which he acknowledges in the following paragraph:—

"As regards the paper just mentioned, I must confess that it was with some feeling of curiosity as to what would be done with it, that I sent it to the Geological Society of London, and after it was read I marked its progress through the council with some of the interest and amusement one feels in watching an uncertain experiment."

It may be asked, why did Mr. Jukes feel any uncertainty as to the publication of his first paper? Fortunately, since that matter was decided, the Royal Geological Society of Ireland have published a number of their journal, or Echo would still have been compelled to answer, Why? The opportune appearance of that publication a few months ago has, however, solved the mystery, and to this effect:—On May 10th, 1865, Mr. Jukes read a paper before that Society, entitled "Notes for a Comparison between the Rocks of the South-west of Ireland and those of North Devon and of Rhenish Prussia (in the neighbourhood of Coblentz)," and on December 8th, 1865, he read another, entitled "Further Notes on the Classification of the Rocks of North Devon;" and it appears to us that they

contain the essence of his papers read before the Geological Society of London. The council of the latter body were probably ignorant of the contents of these Irish papers, or the probability is that they would have saved the cost of fifty pages of their journal. In other words, Mr. Jukes's first paper would have shared the fate of his second.

The council of the Geological Society are in the habit, according to Mr. Jukes, of referring papers to some Fellow, who is supposed to have special knowledge of the subject; and he gives an instance in respect of his first paper, in which the council took the opinion of two gentlemen before coming to a decision. If the council act with such care and deliberation it seems that the theoretical excellence of the referee system (admitted by Mr. Jukes) must be attained in practice. We have ourselves been unable to discover any important new facts in Mr. Jukes's second paper, or any "apparently well-founded corrections of errors as to matters of fact." There is certainly propounded a new view of an admitted fact; but as it is not supported by evidence it could have been given quite as well in an abstract. Moreover, it is so purely hypothetical, that had it been enunciated by a young geologist, it would have been considered too "manifestly childish" for argument. This view may be stated as follows:—Near Wiveliscombe an east and west fault was indicated long ago by Sir Henry De la Beche, stretching for a distance of not more than four miles, and probably less than three. Mr. Jukes's new view, unsupported by evidence, is that this fault is continued for nearly thirty miles in a westerly direction.

Contributors to the 'Quarterly Journal of the Geological Society' are very rarely given so ample a space as fifty pages for the enunciation and illustration of their views, and therefore Mr. Jukes seems a little unreasonable in complaining that considerable further space was not granted for the publication of so feeble an addition to his evidence as that before us. Fellows of the Society who were present at the reading of this paper will remember how prevalent was the opinion that its author, so far from strengthening his case on that evening, had considerably damaged it, by resorting to so far-fetched an expedient as that we have just noticed.

It is also incumbent upon the council of the Society to use the narrow limits of a yearly octavo volume to the best advantage, and there can be no doubt that the time, thought, and trouble expended on the subject by the council as a body, and individually by the respective referees, have contributed in a large measure to obtaining for the Society's journal the well-merited reputation which it enjoys both in England and on the Continent.

Finally, after a careful examination of the evidence, we are unable to come to any other conclusions than the following:—(1)

That Mr. Jukes, forgetting the Geological Society's rules, has felt aggrieved at the refusal to publish in full a paper whose fate he would doubtless have predicted, had he remembered the Society's regulations;* and (2), that he has precipitately written and printed an attack on the council of the Society without first ascertaining that his recollection of the Society's rules was sufficiently exact—a course which can only be compared to rushing into a law-suit without legal advice, on the strength of vague impressions, and with no real knowledge of facts.†

III. FOOD AS A MOTIVE POWER.

By C. W. Heaton, Professor of Chemistry to Charing-Cross Hospital Medical School.

No physiologist now doubts that the force exerted in and by an animal is derived from the combination of the oxygen absorbed in the lungs with the solid or liquid substances formed in the body from the food. Hence it follows that if the body remains unchanged in weight after a certain period of time, the force exerted in it during that period is accurately represented by the calorific value of the food, *minus* the calorific value of the excreta. If the body has increased in weight, a store of potential energy must have accumulated in it; whereas if it has diminished, some portion of the force developed must have been derived from the store provided by previous increase. To avoid unnecessary complexity, it is best to assume the first of these cases, that, namely, in which the food is exactly equal to the requirement of the body.

Whatever intermediate conditions it may assume, there can be no doubt that the force developed in the body is mainly expressed in the final forms of Heat and Mechanical Work. It becomes, therefore, a problem of the greatest importance both to physiology and to dietetics to determine the relation which these two great factors bear to each other and to the different constituents of human food. Much of the work effected by the muscles is afterwards converted, inside the body, into heat, while some of the heat, that, for instance, which is employed in evaporation, is reconverted into work; but these conversions, although they present the gravest difficulties in quantitative investigations, do not affect the main principles which we have to discuss.

The first problem obviously is to find from the day's food, the

* Vol. i., Part 2, 1866.

† It speaks more for the impartiality of the council of the Geological Society that they refused a place to such an eminent geologist for his second paper, than that they granted it for his first against their convictions.—The Editors.

total amount of force, the actual energy, which it is capable of producing when burnt in the body. The materials for this calculation have been supplied by a series of most valuable experiments which have recently been conducted by Dr. Frankland, who published his results in a lecture delivered at the Royal Institution, June 8, 1866. He selected some of the most important articles of food, and burnt one gramme of each of them in a vessel surrounded with water. He noted carefully the extent to which the water became heated; from this it was easy to calculate the calorific value of the food, and from this its work-equivalent in metre-kilogrammes. In the case of nitrogenous foods, such as meat and bread, a certain portion always leaves the body without undergoing oxidation. The calorific value of this residue was determined by Frankland and deducted from that of the food, and we have therefore, for the first time, a trustworthy statement of the actual force-values of these substances. The following table contains a few of the most important figures. A great deal of the enormous differences perceived is due to the different quantities of water which the various substances contain; but even when they are compared in the dry state, great differences are observed. Fats and oils are superior to all other substances in this respect:—

Name of Food.	Actual Energy of 1 gramme as burnt in body.	Weight and Cost of various articles required to be oxidized in the body to raise 140 lbs. to height of 10,000 feet.		
	Metre-kilogrammes.	Weight in lbs. required.	Price per lb.	Cost.
			s. *d.*	*s.* *d.*
Cod-liver oil	3857	0·553	3 6	1 11½
Beef fat	3841	0·555	0 10	0 5½
Butter	3077	0·693	1 6	1 0½
Cheshire cheese . . .	1846	1·156	0 10	0 11½
Oatmeal	1665	1·281	0 2¾	0 3½
Isinglass	1550	1·377	16 0	22 0½
Lump Sugar	1418	1·505	0 6	0 9
Bread	910	2·345	0 2	0 4¾
Lean beef	604	3·532	1 0	3 6½
Potatoes	422	5·068	0 1	0 5¼
Cabbage	178	12·020	0 1	1 0¼

It is curious to compare with these figures the calorific value of coal. The burning of 1 gramme of coal yields an actual energy of 2,538 metre-kilogrammes, and we will assume its price to be 25*s.* per ton. Equal quantities of force can then be obtained by the burning of—

Coal	costing	1*s.*		
Oatmeal	„	35*s.*		
Butter	„	125*s.*	or	£ 6 5*s.*
Lean beef	„	425*s.*	„	21 5*s.*

The food which is the cheapest enumerated as a force producer, is,

thirty-five times as expensive as coal, and it is therefore not wonderful that human labour cannot compete in economy with that of the steam-engine. Food is, indeed, as Donders remarks, a very dear form of fuel.

We have now come to a question which is infinitely more complex than the first, and which embraces the most important of physiological problems. We may suppose ourselves acquainted with the composition and force-value of the food, and we have next to inquire what changes it undergoes and what are its functions in the organism. A complete discussion of this subject would be an elaborate treatise on physiology, and even so would unfortunately afford but a very imperfect answer to the questions. But a few points must be briefly glanced at, and they will serve as an introduction to some recently acquired theories and facts of great practical importance. In the first place it is essential to notice that all the food which plays any important part in the body is first converted into blood. The processes of digestion, absorption, and sanguification have this for their object, and it is unnecessary to consider them in detail here. It is in the blood that our inquiry practically commences. That the blood consists of two parts, corpuscles and liquor-sanguinis, is familiar to everybody, and it has been clearly demonstrated that the corpuscles are the main agents in animal oxidation, taking up oxygen in the lungs and giving it out again in the course of the circulation. Much of the oxidation so effected undoubtedly takes place in the blood, and to this oxidation is attributed by all physiologists a great part of the heat of the body. According to Liebig, it is non-nitrogenous substances only, substances derived from the starch, fat, and sugar of the food, which are oxidized in this way, and no work, but only heat can result from the oxidation. To the nitrogenous compounds of the blood, the albumen, fibrin, &c., he assigned the exclusive function of nourishing, or, as it were, repairing the solid tissues which are undoubtedly subject to incessant disintegration and decay as a condition of their life. He accordingly divided the constituents of food into respiratory and plastic elements, or, to use a simpler nomenclature, into "heat-givers" and "flesh-formers." This brilliant generalization has been adopted by the great majority of physiologists. There can be no doubt that nutritive matter does pass out through the thin walls of the capillaries and irrigate the neighbouring tissues. The cells, or elementary parts, of which a tissue consists, develop and grow at the expense of this nutritive fluid. When the cells have completed their term of life they decompose into simpler forms of matter, and pass back, together with the excess of the nutritive fluid, into the blood. This restoration to the blood is no doubt chiefly effected by the agency of the lymphatics, which take their origin, as recent anatomical research has shown,

in the interspaces between the capillaries. In its passage through the lymphatic glands, all of the lymph that is susceptible of the process is reconverted into blood.

Closely connected with Liebig's food theory, is his theory of the origin of muscular work. The final result of the disintegration of muscular tissue is undoubtedly its oxidation; but Liebig assumed that this was the *immediate* result of it. He supposed, and it is still generally supposed by physiologists, that a portion of oxygen separated from its combination in the blood and traversed the walls of the capillaries with the nutritive fluid, and that as fast as the new cells were built up by the one, the old ones were oxidized by the other; the oxidized and now lifeless products being carried back to the blood to be ultimately excreted from the body as capable of no further use. The force liberated in this oxidation was the force which contracted the muscle, and so did the work. Lastly, it was assumed by Liebig that inasmuch as the muscular tissue was formed from the flesh-formers of the food, and was almost identical in composition with them, the whole work of the body was derived from the flesh-formers, which were therefore a true measure of the amount of work which the body could accomplish. When muscle, or the flesh-formers of food, are oxidized in the body, their nitrogen is chiefly converted into a crystalline substance called urea, the great bulk, if not the whole, of which is excreted through the kidneys. Hence the amount of urea excreted has been adopted by Haughton,* and subsequently by Playfair,† as a measure of the amount of work effected by the organism.

But these brilliant and beautiful theories encountered a certain amount of opposition even from the very first. Lawes and Gilbert, the well-known agricultural chemists, in describing some experiments on the fattening of cattle made twenty years ago, pointed out that the amount of urea which a pig excreted could be doubled merely by doubling the amount of nitrogen in its food, and this without any alteration in the quantity of work it did. Mayer, in a work‡ which will for ever remain a landmark in the history of science, combatted some portions of the theory with irresistible force, and more recently Voit in Germany and Dr. Edward Smith in England showed that the work of an animal could be enormously increased without any proportionate augmentation in the excretion of urea. This, with the important observation of Lawes and Gilbert, proved conclusively that the amount of work done could not be measured by the urea excreted. The theory which Mayer supported with such ability and which had indeed, as Frankland points out,

* 'Dublin Quarterly Journal of Medical Science,' vol. xxviii. *et seq.*

† 'On the Food of Man, in relation to his Useful Work.'

‡ 'Die Organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel. Heilbronn,' 1845.

been foreshadowed by that wonderful genius Dr. Mayow, of Bath, nearly 200 years ago, now began to revive, and Traube went so far as to argue that the oxidation of muscle, far from being the sole cause of muscular work, contributed nothing whatever to it, but that the whole of the work was done by the combustion of fats and hydrates of carbon (sugar, starch, &c.). Traube's calculations have been shown by Professor Donders, of Utrecht, to be inconclusive, but the same view has been recently maintained by two Swiss *savants*, Fick and Wislicenus, who endeavoured to establish it by a very remarkable experiment.* After abstaining for some hours from all food containing nitrogen, they weighed themselves with their accoutrements, and set out at day-break to ascend a neighbouring mountain, the Faulhorn. They ascertained the quantity of nitrogen excreted during and directly after the ascent, and calculated from it the amount of muscle, or other substance of similar composition, which must have been decomposed in the body to yield it. This was easy enough, for nitrogen constitutes about 15 per cent. of each of these substances. After applying certain necessary corrections, they found that the nitrogen indicated about 37 grammes of the dry muscle of each observer. They then proceeded to calculate the amount of force which could be produced by the oxidation of this quantity of muscle. Frankland has since determined this experimentally in the same manner as he did the force-value of food, and I therefore give his figures as being more reliable. He finds that it is 68,376 metre-kilogrammes; more than this amount of work could not possibly have been effected by the burning in the body of 37 grammes of muscle. What then was the actual work accomplished by the two experimenters? The mountain was 1,956 metres high. Fick weighed 66 kilogrammes and Wislicenus 76 kilogrammes, and these weights were raised to the top of the mountain. The work which each experimenter accomplished is therefore found by multiplying his weight by the height of the mountain. It is equal for:—

Fick, to 129,096 metre-kilogrammes.
Wislicenus, to 148,656 „

The oxidation of muscle therefore will not account for one-half of the actual work done, and if allowance be made for the work done by the heart and lungs, and for the fact demonstrated by Haidenhain, that the force developed is always at least double of that actually employed, the result of the experiment is even more striking.

One part of Liebig'stheory, that, namely, which derives muscular work *exclusively* from muscular oxidation, must therefore be finally abandoned. This experiment has but supplied the finishing blow to

* 'Philosophical Magazine,' June, 1866 (Supplement).

what was already untenable; for, even apart from the researches already mentioned, Donders had, in a masterly essay published in 1864,* proved its insufficiency. Fick and Wislicenus indeed feel themselves justified in adopting the hypothesis of Traube, but this is not a necessary result of their experiment.

We have before us therefore two opposite views of the origin of muscular power. One has been already shown to be in its entirety untenable, but are we therefore to conclude, as Fick and Wislicenus have done, that the other is necessarily true? Most important consequences hinge upon the answer to the question, for if the view so long accepted be incorrect, all our notions of dietetics must be revised.

The first argument which is brought against the new hypothesis is founded upon common experience, which certainly seems to teach that a larger quantity of flesh-formers is necessary in the food when extra work is done. The superior strength of the British navvy is usually ascribed, not without probability, to the quantity of meat which he eats; and Donders sagaciously points to the case of the horse, which, as every one knows, may be fed upon grass when in idleness, but must be supplied with oats—a food richer in flesh-formers—if hard work is expected of him. Without assigning too high a value to arguments of this kind, it must be admitted that they are not destitute of force, and that it is somewhat difficult to answer them upon Traube's view.

But more cogent arguments are not wanting. In the first place, it is not literally true that muscular work produces no alteration in the amount of nitrogen excreted; on the contrary, a small though irregular increase is always noted, a fact which has been confirmed within the present year by some well conducted experiments of Dr. Parkes's.† It is indeed difficult, as Donders remarks, to imagine how it could be otherwise in many cases, for some animals may be fed, as Pettenkoffer and Voit fed a dog, and Savory, rats, upon food containing nothing but flesh-formers. In such cases the extra-work being done at the expense of nitrogenous food, must be attended with increased excretion of nitrogen. Moreover, it has been shown by numerous experimenters that the disintegration of muscular tissue is always increased by muscular work. Creatin, creatinine, lactic acid, and sugar, all of them products of the decomposition of muscle, have been found to be present in more than the usual quantity in a muscle which has been repeatedly contracted. Very nearly the whole of these substances are oxidized in the body into carbonic acid, water, and urea. It is therefore argued that the oxidation of muscle is as likely to contribute to the motive power of the muscle

* Translated in 'Dublin Quarterly Journal of Medical Science,' February and May, 1866.

† 'Proceedings of the Royal Society,' Jan. 1867.

as that of the so-called respiratory elements of the food; and I find it impossible to dissent from this view. Ranke, in his splendid essay,* has indeed made use of these facts in support of the theory of Liebig, but valuable as his researches are, they can hardly be said to have made out his case. He proved that some of the products of the decomposition of muscle, and particularly lactic acid, had the power of hindering or even of arresting muscular movement. He found that the feeling of fatigue in an overworked muscle was mainly due to the accumulation of lactic acid in it; that it could be removed by washing out the lactic acid with water, and induced in a muscle which had been long at rest by the injection into it of a solution of lactic acid, or even of an aqueous decoction of a fatigued muscle! From these and numberless other experiments he argued that the amount of work done by an animal was nearly constant, unusual muscular exertion being always followed by a corresponding period of quiescence, which lasted until the products of disintegration were removed from the muscles, or neutralized. But his experiments, although extremely ingenious, were necessarily only of a qualitative kind, and cannot therefore be put in opposition to the direct quantitative proofs alleged upon the other side.

But there is a third view of this great question which was clearly propounded by Mayer, but which seems to have been unaccountably neglected by later physiologists. It appears to me to afford a means of reconciling many of the difficulties which beset the subject. It is founded upon a consideration of the function which the blood fulfils in the matter. When blood traverses the capillaries of a muscle, it becomes darkened in colour. A portion of its colouring matter is reduced to the purple state, and at the same time some of the corpuscles disappear. During muscular contraction these changes are intensified, and the loosely combined oxygen of the colouring matter may even, as Ludwig and Sczelkow have found, be reduced to one-third of the average amount present during rest. Hence, muscular contraction is attended with a more rapid consumption of the oxygen of the corpuscle. According to the current theories we are therefore compelled to suppose that on the stimulus of the motor nerve, oxygen leaves its combination in the corpuscle, passes through, without combining with the easily oxidizible constituents of the liquor sanguinis, traverses the thin walls of the capillary in company with the outgoing nutritive fluid, and only exerts its force and produces oxidation when it is in contact with some comparatively distant muscle fibre. That this is the view usually taken by physiologists is shown by an incidental remark made by Dr. Bence Jones, in his address as President of the chemical section of the British Association at the last meeting.

* Tetanus—Eine Physiologische Studie. Leipzig, 1865.

Alluding to one of Graham's recent discoveries, he said:—"The importance of this discovery in metallurgy, and its application to the physiology of respiration *and of the passage of oxygen from the blood into the textures*, must be apparent to all." But nothing could be more unlikely, on chemical grounds, than such a mode of oxidation. Oxygen, when just liberated from combination, is usually more active in entering into new combinations,* and yet, here we are called upon to believe that a great portion of it leaves one combination without any assignable cause, and remains for a time in a free state, although present in the same solution with matters for which it has a great affinity. That the oxygen of the colouring matter is capable of combining directly with some of the nitrogenous compounds of the blood, is evident from an experiment of Stokes's, in which a solution of blood was found to reduce itself when preserved in a closed vessel. The experiment further proves that the oxidizing power of the blood is not necessarily dependent upon nerve-action, although it may, very probably, be stimulated by it. Mayer saw this difficulty in the current theory of tissue-oxidation, and met it by placing the seat of all oxidation in the blood, and by assigning to the corpuscles the office of effecting directly the whole of it. Both heat and muscular work derive their source, according to him, from blood-oxidation, some portion of the oxidation yielding work, the remainder heat. He says, "The muscle produces mechanical work at the expense of the chemical action expended in its capillary vessels."

Claude Bernard seems to have adopted a similar view, and expresses it occasionally with great clearness. The following passage occurs in his celebrated 'Leçons sur les Liquides de l'Organisme:'†—

"Il est infiniment probable que l'acide carbonique du sang veineux résulte d'une oxydation qui s'est effectuée dans le globule sanguine lui-même. Lorsque le sang traverse les capillaires, il y aurait entre lui et les tissus non échange de gaz, mais peut-être échange de liquides. Par suite des conditions nouvelles que créerait cet échange, l'oxygène du globule serait en partie employé à oxyder le carbone du globule lui-même."

This therefore is the third, and it appears to me the only tenable hypothesis of the source of muscular power. I shall speak of it as Mayer's hypothesis. The blood is the seat of all oxidation, and therefore the originator of all force in the body. Some part of this force is evolved in the form of muscular work, the greater part of

* It is, however, right to add, that oxygen is probably held in cruorine, in what Kekulé calls "molecular combination," since it has been shown that carbonic oxide displaces from it its own volume of oxygen. In this case the liberated oxygen would not be more than usually active.

† Vol. i., 342.

the remainder in that of heat. How it comes about that oxidation inside a capillary is converted into muscular movement outside, we do not know with certainty. The conversion is effected under the control of the nervous system, and we may therefore venture to suppose that some of the force set free during blood-oxidation may, through the agency of the nerves, take the form of electric currents, which are the direct agents in the muscular work. This, however, is little better than a guess, and as such is entitled to very little reliance. The function of the nerves is the most obscure of all physiological problems, and the difficulty which it presents in this particular hypothesis is not greater than that which enshrouds all others on the subject.

The establishment of Mayer's hypothesis would of course render meaningless the controversy between the followers of Liebig and those of Traube, for as both fats and carbohydrates on the one side, and the products of muscle metamorphosis on the other, are oxidized in the blood, both may equally be supposed to be originators of muscular power. It becomes therefore a matter of the utmost importance to test Mayer's view by every means we possess. I think it is possible, by an extension of one of his own lines of argument, to approach very near to a demonstration of its truth. He pointed out that the fluid which passed out from the blood through the walls of the capillaries was afterwards returned to the blood through the lymphatics, and that the quantity of this exudate could therefore be measured by the quantity of lymph. In this way he calculated that not one per cent. of the blood left the blood vessels in the course of the circulation, and he therefore inferred that not less than 99-100ths of the total oxidation of the body must be affected inside the blood vessels. But this argument is not entirely satisfactory, for it might be objected that the exudate, small though it was in amount, carried with it a sufficient quantity of oxygen for the oxidation, and therefore for the work of the muscles. I have therefore suggested another, which appears to me much more convincing. I purposely exaggerate every element of the calculation, in order as far as possible to overstate the case against me.

The first thing to be done is to estimate the extreme quantity of fluid which can be supposed to exude through the walls of the blood-vessels in twenty-four hours. We have better data for this purpose than Mayer possessed. Bidder and Schmidt estimate the quantity of lymph and chyle together daily added to the blood at $28\frac{3}{4}$ lbs. Of this $6\frac{1}{2}$ lbs. is chyle, which comes from the food, and may be left out of the calculation. But I will assume the quantity of lymph alone to be 30 lbs. It may be objected that some of the exudate may return directly to the capillaries without traversing the lymphatic system. If this be the case, the quantity so returned could not be large, as the blood flows at a considerable pressure—a pressure

which would tend to prevent such a return. Nevertheless, I will, on this supposition, double the amount already given, and take it at 60 lbs. A large proportion of this would arise from glands and other parts which do little or no muscular work; but this I neglect. Finally, it may be urged that some portion of the exudate may escape as perspiration without returning to the blood at all. I therefore add 6 lbs. to obviate this source of error, and thus get a total daily exudate of 66 lbs. or 30 kilogrammes, an amount which I think every physiologist will admit is an extreme overstatement.

How much oxygen can possibly be supposed to pass out in solution in this 30 kilogrammes of exudate? Berzelius found that the serum of blood would not dissolve more oxygen than water would. This would give as the quantity of oxygen exuded in 24 hours, less than $1\frac{1}{2}$ grammes; but I will assume that the exudate will dissolve 20 times as much oxygen as this, in fact, that it will absorb more than the moist corpuscles of the blood of the portal vein, which are superior to all others in this respect. The estimate is so extravagant that it is almost absurd to make it. It gives, as the daily exudate of oxygen through the muscles, 25·74 grammes. If the work of the muscles is done by oxidation *outside* the walls of the capillaries, it must all be done by this quantity of oxygen, and it is easy to show that the quantity is entirely insufficient for the purpose, whether it were employed in the oxidation of muscle or of fat.

25·74 grammes of oxygen would oxidize 17·31 grammes of muscle, and thus yield a force of 31,210 metre-kilogrammes, or 8·87 grammes of fat, and thus yield a force 34,070 metre-kilogrammes.

To compare with this I will give an extremely low estimate of the work accomplished in the body in 24 hours, omitting doubtful items:—

	Metre-kilogrammes.
Work of the heart (Donders) . . .	70,000
Work of the lungs	10,000
Work of the muscles	20,000
	100,000

The force actually generated to effect this work must, as Haidenhain has shown, be at least double the above quantity, so that even upon this extravagant calculation, the oxygen, which may be supposed to pass out from the capillaries to the muscular tissues, can only account for about one-sixth of the work done by the muscles.

The establishment of Mayer's hypothesis would unfortunately not help us much in the solution of the practical question, What kind of food is most suitable for the man who does hard work? Both flesh-formers and heat-givers are available for the purpose, and provided the former are sufficient to repair the daily waste of the tissues, it is possibly immaterial which is employed. Even this,

however, is not certain, and as we are still ignorant of the exact relation which tissue disintegration bears to work, we cannot as yet pretend to determine *à priori* the quantity of flesh-formers necessary under conditions of work. The practical solution which experience has provided for the problem must for the present rule our dietary scales, although it can hardly be doubted that a more scientific knowledge upon the subject will before long be gained.

IV. LIGHT AND DARKNESS.

Winslow on Light.*—Johns on the Blind.†

Regarding the nature of Light, there have been, and perhaps may still be said to be, two distinct theories extant. The older view conceives of light as a form of matter, infinitely diffused, but still *matter*, which is itself projected from the light-emitting body, and falls upon the surrounding objects; the newer theory treats light as a force, and necessitates the belief in an interplanetary Ether, also a form of matter infinitely attenuated, but capable of being agitated in waves by the luminous force. The latter or undulatory theory of light, which makes it to be a mode of motion, is now almost completely established, and although the human mind cannot yet form a proper conception of the interplanetary ether, the medium acted upon, still that may be said also to be one of the acknowledged facts of physical science.

Around this subject cluster many eminent reputations; that of Newton stands out the most prominent; it was he who first analyzed a ray, and showed it to be far more complicated than it appeared to be without the intervention of the prism. The elder Herschel and Ritter revealed the character of the non-luminous but calorific, and chemical, or as Robert Hunt has called them, the Actinic Rays. Stokes, Hunt, Locke, Joule, Balfour Stewart, Tyndall, and many others, have added to our knowledge of the nature and effect of light; and yet that knowledge is but in its infancy.

Wonderful as are the operations of light upon inanimate nature, operations which have caused it to be employed in photography to perpetuate the memory of the living and to recall most vividly the history of the past; still more wonderful is its influence upon living forms, whether in the animal or plant world.

* 'Light—its Influence on Life and Health.' By Forbes Winslow, M.D., D.C.L., Oxon. Longmans.

† 'Blind People: their Works and Ways, with Sketches of the Lives of Some Famous Blind Men.' By Rev. B. G. Johns, M.A., Chaplain of the Blind School, St. George's Fields. Illustrated. John Murray.

Its absence or presence causes marked modifications, not only in the colours of plants, but in their growth. It attracts vegetable forms or parts of them in the most extraordinary manner, and with recurring regularity. A wonderful sight, well known to microscopists, is that of the little volvox-globator, gathered in a green mass towards the light when some water containing these exquisite forms is exposed to its influence. Every child has watched the sunflower as its great round face is turned, as though by some machinery within, and follows the orb of day in its course through the heavens; and does not the gastronomic epicure well know that his asparagus, if carefully bedded up and kept in darkness, will not have the green hue which it assumes as soon as its head peeps above the soil?

And as to men and animals, we have only to look at the stunted creatures of the dark and cold regions of the world; or at those who are bred underground or in the dismal courts of large cities in our own temperate zone, to be satisfied that with light we have robust, strong, and well-developed bodies; and without it, the reverse of these qualities.

As we have already stated, the undulatory theory of light is now the accepted theory; and although the *nature* of the interplanetary ether which fills all space is a matter of individual conception, yet the presence of some such medium must be recognized along with the dynamic theory. And when we come to consider the nature of those material forms and organizations which must be permeated by that infinitely attenuated form of matter before light can penetrate them, and compare some of the transparent solids with fluids or gases which are only partially translucent, we become still more puzzled to understand the character of the medium upon which the force acts that we term light. The arrangement of the atoms which exclude it from one portion of our precious organ of sight, and concentrate it in another, are truly marvellous, and sad indeed is the fate of the creature in whom the natural order of the parts is so disturbed, that whilst all is bright, heavenly, smiling light without, there is nought but gloom and darkness within.

Dr. Winslow tells us but little worth remembering, and almost nothing that is new, concerning the physiological effect of Light, and sums up his information upon that portion of the subject with which we should have supposed him to be the best acquainted (namely, the influence of light upon the insane), with the admission that he knows little or nothing about it, and in these words, "I freely admit that placing but little faith in what has been recorded or said on the subject, I have not kept any systematic register as to the effect of different phases of the moon on the insane."*

Of the modern theories of light we take him to be ignorant, for

* P. 233.

whilst we have to wade through page after page of valueless gossip as to what men in semi-civilized ages believed concerning its nature and influences, we are told in a brief sentence that "it would be irrelevant to enter into the discussion of the varied theories of light that have been propounded."* With the science of Zoology, too, the author seems to be but little better acquainted, and nothing is more annoying than to find, that as soon as he approaches a portion of his subject at all likely to be interesting, he dismisses it with some passing remark, which shows that he has never given the question a serious thought or is unable to deal with it from recent information. Indeed, it would have been better for the author's reputation if he had left this work unpublished; and before he sits down again and attempts to deal with a subject of such vast importance, we should recommend him to keep a diary of his personal observations, which would be sure to be interesting and valuable, instead of putting together a mass of useless information, which commences with nothing and ends as it begins.

But of Mr. Johns's book we can speak in a widely different tone.

He tells us honestly what is the real effect of darkness upon the minds of those who are deprived of sight. Every line he has printed is suggestive and full of meaning, and to many a seeing reader, his story of the blind, their works and ways, will give fresh light and impart new sympathies.

Some persons may be disposed to think that the honest estimate which he gives us of the mental and moral qualities of the blind, might to some extent withdraw public sympathy from them, but that will by no means be the case. He shows indeed that they are apt through neglect or indulgence to become selfish, suspicious, and irreverent; that a human being born blind can never attain the mental standard which he would reach if he had received all his senses; but these facts (which apply equally to the deaf and dumb) in no-way lessen the responsibility of those to whose care the blind are entrusted; quite the reverse; if it has pleased Providence to deprive them of a certain sense, and place them in a position of inferiority in that respect, it becomes the duty of those who can see, to use every possible expedient for supplying the place of the missing sense, and to keep the patient clear of those quicksands, to which the loss of eyesight exposes him.

The author's account of the progress of a blind boy under instruction is deeply interesting. When he first enters the Asylum or School,—

"It is all so utterly new and strange to him, that for the first day or two he is entirely dependent upon some pupil's or teacher's hand to get as far as the school-room, the chapel, dining-room, or

* P. 3.

basket-shop, all of which are widely apart, but first impressions with the blind are all in all, and within the week the chances are that out of his 80 blind fellow-pupils he has chosen one as a companion and probably his friend, and for several years to come, who, if need be, conveys him across the open yard to any special point; to the dormitory or through the more intricate navigation of staircase leading to the band-room. In a month all the plain sailing is fairly mastered. He can find his way from the dining-room to the basket-shop, and down that shop 150 yards long, just to the very site of his own box, on which he sits to split the withies for basket-work. He knows his own box, too, from Smith's and Brown's on either side of him. In a year he will know probably his own tools from theirs by some little flaw or feature, not patent to the eye of the looker-on; in a couple of years he will know the handle of the door to music-room, No. 5 from that of No. 6; he will run quickly with a half-finished basket in his hand from the workshop, across a wide yard, exactly to the very door-step of the open shed in which is a tank for soaking his willow-work."*

Of his touch, the author says:—"By it he knows his own clothes and almost all the property he possesses: his tools, box, bed, hat, fiddle, cupboard, seat in chapel, school-room, and workshop; by it he reads his chapter in St. John and Robinson Crusoe; he plays chess or dominoes, works a sum in long division, or writes a letter home to his mother, which she can read with her eyes and he with his fingers. By the help of touch he weaves a rug of coloured wools, embracing every variety of scroll-work or of those peculiar flowers and fruits which grow only on carpet-land; or fringes with delicate green and red; a door-mat for a lady's boudoir; by touch he *sees* any curiosity, such as a lamp from the Pyramids, or a scrap of mineral which you describe to him, and which, having once handled, he always speaks of as having seen. He *thinks* he can read a good deal of your character by touch when you shake hands with him; and when he has heard you talk for a few minutes he will make a good guess at your age, temper, ability, and stature. "Saunderson" (a blind mathematician whose history the author gives in another chapter) "at times guessed even more than this. He had been sitting one day and pleasantly chatting with some visitors for an hour, when one of them wished the company good morning and left the room. 'What white teeth that lady has,' said the sarcastic professor. 'How can you possibly tell that?' said a friend. 'Because,' was the ready answer, 'for the last half-hour she has done nothing but laugh.'"†

The author describes with equal vivacity and effect the various employments of the blind. How they work arithmetic; emboss letters; weave; play chess; write poetry; the latter he believes

* P. 9 and 10. † P. 11 and 12.

that those born blind can never do with full effect, for their conceptions of external nature must be erroneous, and he shows that their verses are rather high-flown than poetical.

As regards the infidelity of Saunderson, the blind mathematician; we think that the author, who is an orthodox clergyman, takes an erroneous view of it. There are many considerations which have not occurred to him, and he judges not only the blind mathematician, but also other blind people somewhat incorrectly in this respect.

In the first place, if the mathematician had *seen* he might have been just as great a sceptic; we know mathematicians who require mathematical proofs of everything. Now Saunderson did believe in the "God of Newton."* Again, he tells us† that he "fell into excess in matters of drink;" and was naturally morose and sarcastic. Should he then judge other blind people by such a standard, or attribute Saunderson's scepticism to his blindness? Is he aware that in his description of the habits and character of the blind, he is himself sometimes a little hard? He must see great contrasts, too; a trust far more implicit than those can have who *see* as well as think; and which presents in greater contrast the scepticism which he believes to be exaggerated by physical darkness. But these are trifling faults in his admirable book.

We quite agree with the author concerning the form of embossed type to be employed. It should "resemble as nearly as possible the type in use amongst seeing men, that the blind scholar in learning to read may have every possible help from the remembrance of letters he *may* once have *seen*, but which now his fingers must feel for him, or from any one who can read an ordinary book, or if need be, that a friend may read to him.‡ The words must be *correctly* spelt in full" (not phonetically written, as in some systems in use among the blind), "that when he learns to write, others may read his written words;" and all should be clear and well defined, that his hardened fingers may easily trace the letters.§

The author cites some wonderful instances of retentive memory among the blind:—"Miss Walker, who had mastered five languages and knew all the Psalms and New Testament by heart," and a young man now in the school in St. George's Fields, "who can repeat not only the whole of the 150 prayer-book psalms, and a large number of metrical psalms and hymns, as well as a considerable amount of modern poetry, including Goldsmith's 'Deserted Village,' but—incredible as it may seem—the whole of Milton's 'Paradise Lost,' with marginal notes and a biography.‖

In addition to a large amount of valuable statistical information, the author gives us some useful hints as to the causes of blindness,

* P. 53. † P. 178.
‡ There appears to be some clerical error here.
§ P. 117. ‖ P. 65.

and we can well believe that "two of its stanchest allies" are "typhus and scarlet fever."

Here comes another piercing cry on behalf of the poor which reaches to our inmost souls; a cry for pure air; pure water; light; roomy and cleanly dwellings; and a blow at that great curse of our day, the gin-shop! Ask, What is the cause of deafness? and you will hear, Scarlet fever and typhus. Whence arises blindness? again, "Scarlet fever and typhus." Epilepsy? "Typhus." Insanity? "Typhus." Ask again, Whence comes scarlet fever and typhus? and the answers are, "Drunkenness; overcrowding; filth; impure water; impure air!" When will men turn their *earnest* thoughts to "reform bills" for the cure of these evils?

Mr. Johns gives some short but interesting biographies of blind men; of Huber, the well-known blind naturalist; Metcalf, the road-maker; Stanley, the musician; Saunderson, the mathematician. He also tells some humorous anecdotes of blind tramps and beggars; and gives a poetical account of a visit of Mendelssohn to the Blind School at Zurich:—

"He was there in the hot summer of 1842 to rest and recruit his overtaxed brain, and though besieged by a crowd of eager musicians and amateurs, would accept of no invitation. But hearing that the pupils of the Blind School were most anxious, as *they* said, to see him, in their favour he made an exception. He spoke to the sightless assembly in kindest words; he listened to their songs and choruses, and score in hand, to some even of their own compositions, showing clearly his interest and pleasure. Seeing a correction on the score, and finding it to be the blind musician's own work, 'It is right,' he kindly said, 'and makes the passage more correct, but it was better and more striking before; take care that your corrections are improvements—a cultivated ear wants no rules, but is its own rule and measure.' And then the great musician asked permission to sit down at their piano, and wandered away into one of those wild and tender strains of speaking melody for which he was so famous. His silent, wrapt audience listened so intently to the 'song without words,' that a pin-fall would have broken the stillness. One by one, over the eager faces, crept the air of deep, quiet joy, until in the midst of the great flood of mingling harmonies, a voice came to them out of the very chorus they had just been singing. Then their enthusiasm knew no bounds. The great master had carried them away at his will, to heights of joy and triumphant praise before unknown; he had whispered to them of sorrow, and the cloudy ways of life, in words of soft unbroken tenderness; and now he stirred their inmost depths by a strain of their own weaving, into which he poured a new tide of living song, new grace, and new meaning. No words could tell what they felt; they could have pressed him to their very hearts for joy. This was

not long before the great musician's death; but he still lives in the Blind School at Zurich, and there still remains, as a precious relic, the master's chair in which he sat."*

With this extract we close Mr. Johns's book; and we must admit that having opened it with a critic's eye, and with the reviewer's thoughts, as we advanced in its perusal we were more and more sorely tempted to "cut it up," and to transfer the rich and fertile "cuttings" bodily into the pages of this Journal. But that would not have been fair to the author, and we hope that the lengthy extracts which we have been led to insert, along with the excellent illustrations, which we can *not* give, will do something towards securing for the author that large circle of readers to which his honest, truthful, and poetical descriptions of the works and ways of the blind are justly entitled.

V. THE SYSTEMATIC STUDY OT ANNELIDS.

1. Johnston: *Catalogue of Worms* (*Brit. Mus.*), 1865.
2. Kinberg: *Eugenies Resa* (Aproditea), 1857.
3. Schmarda: *Neue wirbellose Thiere.* 1861.
4. Ehlers: *Die Borstenwürmer* (1*st Part*), 1864.
5. Malmgren: *Nordiska Hafs-Annulater,* 1865.
6. De Quatrefages: *Annélides et Géphyriens,* 1865.
7. Malmgren: *Annulata Polychœta Spetsbergiæ, Grœnlandiæ, Islandiæ, et Scandinaviæ,* 1867.

THERE can be little doubt that human knowledge and science have hitherto presented, and will continue to present, the same order of evolution as other progressive phenomena. We trace it from the simple to the complex, from the general to the special; but most markedly and distinctly has it progressed from the comprehension of plain and obvious facts and appearances, to that of less plain and less obvious phenomena. Small though the illustration may be, yet it is worth remarking that the various phases through which the study of systematic zoology has passed, furnish a very clear instance of this progress. Omitting the classification of Aristotle—which was far in advance of the philosophy of the contemporaries or disciples of that marvellous man—we must start with Linnæus, as the father of modern Zoology. Of invertebrate animals, he only distinguished two great groups, his Insecta and his Vermes, the latter being a heterogeneous assemblage of all the creatures whose characters were less *obvious* than those of the former. Cuvier separated the Molluscs and Ringed-worms from this group when he gave to the world his fourfold division of the animal kingdom; but these same

* P. 99 to 101.

Ringed-worms and his Radiata were obscure groups, and the former have up to the latest years been badly treated. Whilst Linné's Insecta have been everywhere studied and ardently collected, whilst shell collectors and conchologists flourish in every small town and village, and over thirty pounds is not unfrequently given for some rare *Cypræa*, but few men are to be found who would hunt out worms from their secret retreats, or keep a collection of their beautiful forms preserved in spirit. Linné himself knew the characteristics of but very few worms, and only made five genera of Annelids (properly so called), making thus a much smaller advance upon his predecessors than in the case of Insects and Molluscs.

The reason of this is to be found in the general obscurity surrounding these animals; not only are they obscure in their habits, hiding deep in sand and mud, lurking under stones or in the cracks of rocks, but the differences which separate them specifically and generically from one another are not at all obvious, nearly all conforming to two or three types of general shape and appearance, whilst many are minute and fragile. Add to this that they can only be preserved in spirits or similar fluids, and the list of difficulties is complete. By some of the authors, the title of whose works we have placed at the head of this article, the microscope has been used most successfully in finding sure characters by which many species can be distinguished; and under the auspices of MM. Kinberg, Malmgren, and Ehlers, the study of Annelids is assuming a character of certainty and definiteness which cannot fail to attract new workers. Nothing can be more beautiful of its sort than a collection of Annelids preserved in spirits, many having the most gorgeous hues and most graceful forms; surely it will not be long before we have numerous collectors and devotees of worms, who will of course call themselves Annelidologists or Scolecologists, or by some other equally euphonious title.

We wish here briefly to point out the structures which are made use of in arranging Annelids and determining their species by M. Malmgren and his colleagues, leaving aside the general anatomy and physiology of the group, in which there is very much yet to be learnt and done.

The term "Annelids" does not convey to the mind of every naturalist the same meaning; and it is as well, perhaps, to settle upon some one of the limitations of the group given by various writers. Cuvier's Annelids included the marine bristle-bearing worms, the earth and fresh-water worms, and the leeches. Lamarck, Savigny, and others included with these that curious group of animals connecting the Worms and Echinoderms—the Gephyrea. Dr. Johnston, again, embraces in his group of Annelids the soft, ciliated, ringless Turbellaria, whilst MM. Van Beneden and Gervais turn out the Leeches and admit the Gephyrea. For the

student of species and their general superficial relations, there can be no doubt that Ehlers' group of Chætopoda, embracing the marine and fresh-water bristle-bearing worms (Borstenwürmer), the Polychæta and the Oligochæta of Grube—to the exclusion of Leeches, Gephyriens, Turbellarians, and such-like doubtful orders—forms a very convenient and well-limited field of work.

Understanding thus, then, the term Annelids, let us see what striking characteristics they present in common. In the first place, the body is composed of a series of more or less similar rings, from which in all, a single or double series of horny bristles or hooklets is developed on each side of the body. In the marine Chætopods a soft appendage, or "foot," is also developed on each side of most of the rings, and three or perhaps more of these rings coalesce to form a head, which in many cases is very highly organized. In the earth and fresh-water Chætopods, on the other hand, no foot is ever developed, and the head consequently has a quite simple form, destitute of any tactile or sensory appendages. The modifications of the head and feet (in those species possessing them) and the form of the bristles or setæ, which require a microscope of high power for their examination, are the characters which are available for generic, specific, and other divisions. It would be impossible here to run through the whole group of Chætopods, which embraces now many hundreds of species; we may, however, take one or two examples from Dr. Malmgren's last published work.

The genus *Aphrodita*, into which Linné threw all the scale-bearing Annelids he knew, has been gradually broken up into nearly thirty genera, grouped in four families. We have selected two common species belonging to the same family, Polynoïna, but to different genera, for illustration: the one is the *Lepidonotus squamatus*, the other the *Harmothoë imbricata;* they are both about an inch-and-a-half in length, and frequent the same habitats, *viz.* the under-surfaces of rocks and stones within tide-mark. These two forms and the species allied to each were, till the observations of Kinberg, kept in one genus, *Lepidonotus*, as defined by Leach. In Figs. 1 and 2 the heads of these two worms are drawn very carefully on an enlarged scale. In each there is a more or less bifid cephalic lobe, carrying two pairs of eyes, and connected with a median tentacle, *pt.*, a pair of antennæ, *a.*, a pair of palpi *P.*, and two pairs of tentacular or peristomial cirri, *p.c.* These parts and their bases are all disposed around the cephalic lobe, and form the head; but in *Lepidonotus*, the antennæ arise from the tips of the cephalic lobe, whilst in *Harmothoë* they spring from the base of the median tentacle. A further very concise difference is exhibited by the setæ fixed in the soft feet, which are broader and more deeply serrated in one than the other (Figs. 5, 6, 9, 10). The foot differs in each a little also in the proportion of its parts. It is an example of

that sort of foot which is divisible into two branches, a notopodium and a neuropodium (Figs. 7 and 8, *ntc. nrc.*), each of these two parts carrying a cylindrical appendage or cirrus and its bunch of setæ. The notopodial cirri in the two figures differ considerably, resembling the peristomial cirri: they are smooth in *Lepidonotus*, but carry short papillose hairs in *Harmothoë*. The group to which the Polynoïna belong is remarkable for having flat scale-like bodies covering the back, placed in pairs on the alternate rings, or, as in the Sigalionina, on nearly every ring. The scales are in many species very beautiful objects, and furnish very important means of distinguishing forms. In the genus *Lepidonotus* there are only twelve pairs, and these adhere firmly to their attachment; in *Harmothoë* there are fifteen, or sometimes, twenty pairs, which very readily slip off from the body. In Figs. 3, 4, the scales of the forms we are noticing are drawn. Those of *H. imbricata* exhibit the greatest variation in colour, being brown, black, purple, yellow, or mottled with these colours.

Let us glance now at another very different-looking group of Annelids. The Nereids are long snake-like worms, often attaining a length of ten or twelve inches. In the plate, the head of *Nereis pelagica* and some of its setæ and a foot are drawn (Figs. 11, 12, 13), the parts homologous with those of the Polynoïna just described are similarly lettered. The very characteristic form of the setæ is of great value in grouping the species of this family as well as the lobation of the feet.

The suppression or modification of the parts of the foot and their homologues attached to the head, constitute the essential differences of the various tribes of marine worms. In some, the rings immediately succeeding the head differ from the most posterior in the form and character of their appendages; in most of these the appendages of the head are curiously modified so as to form long filamentous branchiæ, Fig. 15, and sometimes also in tubicolous species an "operculum" which closes the tube in which they live. The greater or less development of a thoracic region has thus led to the division of marine Chætopods into two principal groups, the Errant and the Sedentary, the latter group comprising those in which the thoracic region is present; a third group is sometimes distinguished which bear a superficial resemblance to the earth-worms, and have been, by some writers, associated with the Sedentary, by others with the Errant forms. The modifications of the foot and its appendages are the most remarkable in the Errant group, whilst the head exhibits the greatest peculiarities in the Sedentariæ. In *Phyllodoce* (an errant genus) the notopodial cirrus has the form of a large leaf-shaped appendage; the rings forming the animal being very numerous, there are often more than a hundred pairs of the appendages, frequently brilliantly coloured, with which the animal rows itself

through the water. In *Eunice, Nerine,* and *Arenicola* branchial filaments are developed in connection with the foot, in which the red fluid of the worm circulates. In *Syllis* the cirri are very long and moniliform, attaining in a kindred genus, *Guttiola,* a length considerably greater than that of the worm's body, to which they seem attached like so many Gorgon's locks. In *Polyopthalmus* an eye is developed on each foot. The further modification of these parts leads to very numerous minor generic divisions, all resting mainly upon differences in the form of the appendages and setæ of the foot, and only to be discovered by attentive and careful examination with the microscope.

Various forms of setæ are drawn in Figs. 14, 16, 17, 18, belonging respectively to Sabellaria, Praxilla, Leprea, and Leucodore, and all equally characteristic of the genera and species to which they belong.

The Oligochæta (fresh-water worms) have not received even as much attention as the Polychæta (the marine), and indeed this is not surprising, for without the use of a microscope applied to the setæ, it is impossible to distinguish some of the species with any certainty. Much has yet to be done with this group of Annelids; for it has not at present been touched upon by Kinberg, Ehlers, or Malmgren. The setæ are fewer in number in this group (whence its name) than in the one we first looked at, and there are no appendages in the form of feet; hence the setæ become of still greater importance to the zoologist.

In some species (*Tubifex*) the setæ are hair-like bodies; in others they are stout and short (*Lumbricus, Phreoryctes*), Fig. 20, 21; in others again they have a bifid apex (*Chætogaster*), Fig. 24; or this sort of setæ may be associated with other hair-like ones (*Clitellio,* &c.), Figs. 22 and 23; in *Ctenodrilus* the setæ are pectinated, Fig. 25.

There are many species of Oligochæta, though the group is far less numerous than the Polychæta. They are to be found in moist earth, in the ooze of streams and rivers, and in sandy soils also. Some writers contend that no Oligochæta are marine, whilst it is certain that no Polychæta are fresh-water or terrestrial.

The geographical distribution of Chætopods is a matter of which very little is known, Schmarda's and Kinberg's works being the principal sources of information, whilst M. de Quatrefage's volumes contain figures and descriptions of many foreign species. It appears that very many genera are cosmopolitan and apparently some species; but on this matter we must hope for sounder information when we have students of Annelids as ardent and numerous as our entomologists, ornithologists, and other specialists.

The study of the development and anatomy of the Chætopods does not belong to the specialist, and whilst it no doubt has a higher importance than the mere recognition of specific differences, cannot supersede such work. There are many men whose minds are so

moulded that the power of investigating anatomical and embryological structures does not belong to them, whilst they may possess the most acute perception of specific differences of form and exhibit great patience and skill in the collection and arrangement of specimens. There are other men who have no sympathy with the accumulators of species, and see but little value in such work, devoting themselves rather to anatomical and physiological researches. There is work for both classes of zoologists, both are valuable labourers; for men combining the powers of the two are few and far between. It is to the first class that we look for an extended knowledge of the Annelida; we believe we have shown that there is a wide but well-defined field of study in the Chætopodous Annelids—and trust that some fresh workers may be induced to enter on it.

One word remains to be said with regard to each of the books in particular, the names of which stand at the head of this article.

We must warn intending "scolecologists" against the 'British Museum Catalogue of Worms,' which is very far indeed behind its time, and will be of but little use. It would be unjust to blame Dr. Baird for this, whose name stands as editor. The work is really the old notes accumulated during many years by Dr. Johnston, and was almost in its present condition ten years since, when it was quite up to the time. Grube's researches on, and classification of, Annelida, have since become everywhere recognized, and now the Catalogue can only be found useful as furnishing a list of localities and some few observations on habits, colour, &c., by that very excellent observer, the late Dr. Johnston.

Kinberg's work on the *Aphroditea*, collected by the exploring ship 'Eugénie,' is of great value, since it is written in Latin, contains the definitions of many new genera and species, and is well illustrated.

Schmarda's work contains descriptions and coloured illustrations of a great number of species from all parts of the world.

Ehlers' Borstenwürmer promises to be a most complete and valuable work as far as the characters of genera are concerned. The large, finely drawn plates are among the most beautiful we have seen. The work is, however, chiefly interesting to the anatomist.

In 1865, A. J. Malmgren, one of the indefatigable Scandinavian zoologists who number amongst them Sars, Loven, Steenstrup, Lilljeborg, Kroyer, and Kinberg, published the first part of a work on the North Sea Annelids (5), which will be of the greatest value to the English Student. The descriptions, localities, and such matters are given in Latin, and hence ignorance of the Swedish tongue need not deter any one from using the book. The part already issued contains the species belonging to the Aphroditacea, Polynoïnia, Acoetea, Sigalionina, Phyllodocea, Nephthydea, and Lycoridea, illustrated with detailed drawings of the heads, setæ, feet, and other

appendages, executed with great care. We have also received from Dr. Malmgren an illustrated Catalogue of the northern Annelids in the Stockholm Museum, in which many additional species are figured, and some valuable remarks on the species in the British Museum collection examined by him, are given. The synonymy of species, which is always a troublesome matter, is unusually perplexing in the Annelids, and Dr. Malmgren has devoted great pains and research to setting it on a right basis.

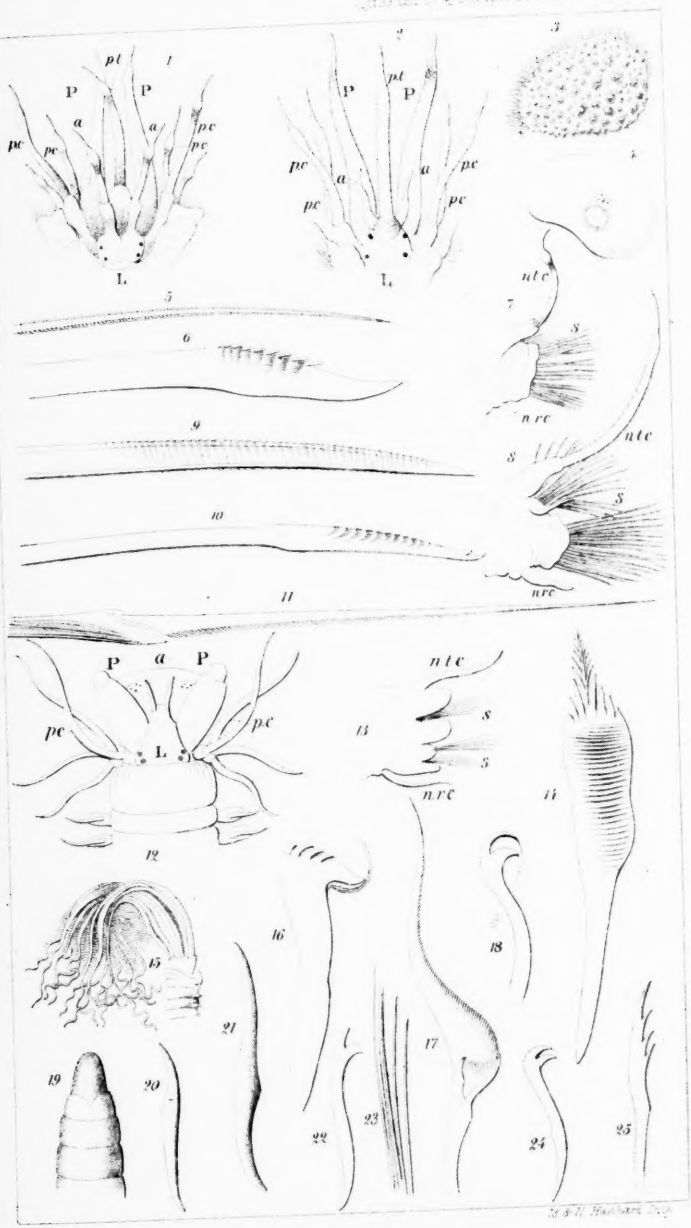
The brilliantly illustrated volumes published by M. de Quatrefages in 1865 will be found very useful. They contain most excellent chapters on the anatomy and general natural history of the class, and descriptions of many species. The absence of figures of many of the new species renders them rather obscure. M. de Quatrefages has not consented to the minute generic divisions of some of his contemporaries, and indeed we venture to think Dr. Malmgren has carried this method of arrangement a little too far; in the family Polynoina, the genera proposed by Kinberg seem to us sufficiently minute—they were six in number; but Dr. Malmgren is not content with less than seventeen.

A work on the British Annelids and Turbellarians is promised by the Ray Society. Dr. McIntosh is the gentleman who has undertaken this gigantic task, and he really needs all the help that can be given to him by local and other naturalists. Specimens and coloured drawings from life are the only way in which this help can be given, and we trust that Dr. McIntosh may not long have to grapple with the Annelids single-handed.

EXPLANATION OF THE PLATE.

Fig. 1. Head of *Lepidonotus squamatus*, after Kinberg; *L.* cephalic lobe; *pt.* prostomial tentacle; *a.* antennæ; *P.* palpi; *p. c.* peristomial cirri.
Fig. 2. Head of *Harmothoë imbricata*, after Malmgren; letters as in Fig. 1.
Fig. 3. Elytron of *Lepidonotus squamatus.*
Fig. 4. Elytron of *Harmothoë imbricata.*
Fig. 5. Notopodial seta of *L. squamatus.*
Fig. 6. Neuropodial „ „
Fig. 7. Foot and appendages of *L. squamatus.* *ntc.* notopodial cirrus; *nrc.* neuropodial cirrus; *s.* setæ.
Fig. 8. Foot of *H. imbricata;* letters as in Fig. 7.
Fig. 9. Notopodial seta of *H. imbricata.*
Fig. 10. Neuropodial seta „ „
Fig. 11. Notopodial seta of *Nereis plagica* (after Malmgren).
Fig. 12. Head of *Nereis pelagica;* letters as in Fig. 1.
Fig. 13. Foot of *N. pelagica;* letters as in Fig. 7.
Fig. 14. Seta of *Sabellaria spinulosa* (Malmgren).
Fig. 15. Head of *Chone Duneri* (Malmgren).
Fig. 16. Seta of *Praxilla gracilis* (Malmgren).
Fig. 17. Seta of *Leprea textrix* (Malmgren).
Fig. 18. Seta of *Leucodore ciliata.*
Fig. 19. Head of *Clitellio arenarius.*
Fig. 20. Seta of *Phreoryctes Menkianus.*
Fig. 21. Seta of *umbricus terrestris.*

XUM



PARTS OF ANNELIDS.

Fig. 22. } Seta of *Clitellio.*
Fig. 23. }
Fig. 24. Seta of *Chætogaster vermicularis.*
Fig. 25. Seta of *Ctenodrilus pardalis.*
N.B.—The figures are enlarged to different scales; the setæ are very highly magnified.

VI. ON THE APPLICATION OF SEWAGE TO THE SOIL.

By nature man is improvident; in the midst of plenty he is wasteful and inconsiderate; and it is perhaps one of the chief blessings of civilization, that it brings with it conditions calculated to reform this defect in his character.

Where food is plentiful, and the surface of the earth thinly populated, men think little of economy in regard to the products of the soil, and rarely reflect upon the necessity of providing either for their own future wants or for those of their posterity. But in those countries where the land is valuable, the population crowded, and where men are dependent for the supply of their wants upon the industry and productions of neighbouring states, their sense of foresight is quickened, and they cease to think of to-day only, and seek to penetrate into and provide for the future.

In our last number we drew attention to a movement which has for its object the provision of improved dwellings for the artisan class in our large towns, and we then expressed the view that legislation on that subject is of far greater importance to the well-being of the community, than any enactment in connection with the enfranchisement of the lower classes;* and now it becomes our duty prominently to direct attention to another national reform which will, we feel confident, be regarded at no very distant period, as equalling if not exceeding in importance either of those to which reference has been made; namely, the utilization of sewage, especially in our large towns.

Our readers little dream how wide and numerous are the ramifications of this question. The successful execution of the scheme will save innumerable lives, will conduce to the comfort, add to the means of support, and cheapen the food of the poorest as well as of the richer classes.

Without such a reform, our cities would soon become (what portions of them are already) centres of pestilence; meat and bread would be enhanced in value even more rapidly than they are at present; waste lands would remain waste lands for ever, and whilst we should neglect, as now, the most useful fertilizing agent that we possess, casting it into the sea as an alternative to prevent its polluting our rivers and destroying the valuable stores of fish which

* "The Artizans' and Labourers' Dwellings Bill:" Quarterly Journal of Science,' No. xiii., p. 215.

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they contain, we should still be obliged to import at an enormous cost similar materials from foreign lands, which are becoming rapidly exhausted by the constant drain upon them. Certain principles are now well established with respect to this great question, and these may be enumerated as follows:—

First, in regard to its sanitary aspect. The present system of disposing of the refuse of our large towns by removing it in a dry (or we should rather say, moist) and solid condition is unhealthy and difficult, and with an increasing population it will become more so from year to year.

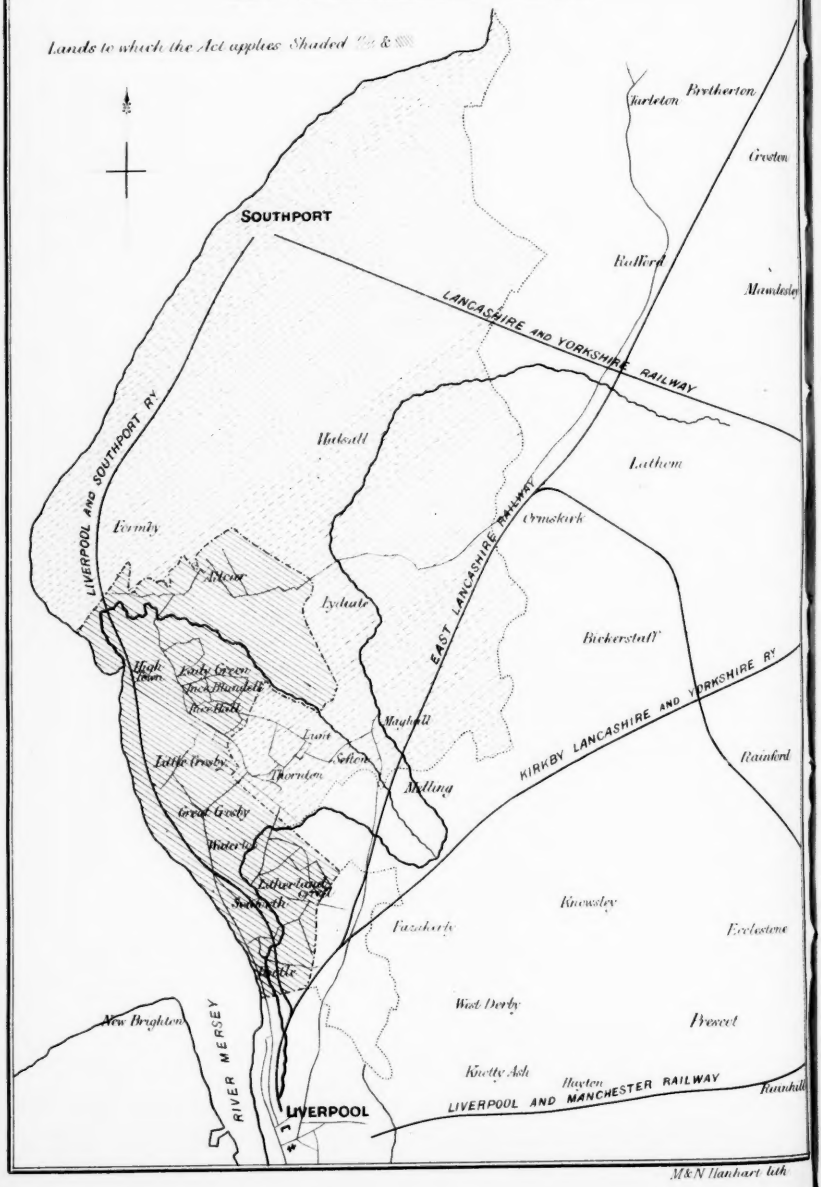
Great care will be necessary in effecting the change from the "dry" to the "wet" system, for it has been shown beyond a doubt, that the larger the amount of fæcal matter discharged into the sewers, the greater will be the difficulty in preventing the escape of noxious gases; and it was recently shown by an opponent of the new system, that an imperfect construction of the water-closet or of its connection with the sewers, might even lead to the pollution of the drinking-water supplied to families through the suction or passage of gases from one set of pipes to the other.

To obviate these difficulties two conditions are necessary; carefully constructed appliances for receiving, carrying away, and storing (when not required for immediate use) the sewage to be utilized, *and a large and constant water-supply.* It would be wasting our own time and that of our readers, to discuss the various minor objections which have been raised against the new system, either by persons interested in some patent, or by those who have hobbies of their own to ride. The fiat has gone forth, that the old system of defecation shall cease; it is troublesome, noisome, degrading (*very* degrading to those labourers who are employed upon it), and barbarous; and it kills its hundreds annually in our large towns.

Just as we have plainly stated the sanitary difficulties as well as the advantages of the new system, so we will now, with equal frankness, detail its commercial and economic benefits and refer likewise to its difficulties. The immediate and undeniable advantages which have already arisen, and will continue to result from the application of sewage to the soil are, the recovery of waste lands and an increase in the area of pasture land, and with it a larger supply of meat, butter, and cheese. To these advantages we see at present no limit even in Great Britain. It is merely a question of steam-power and iron-piping—and there is not a sandy common, foreshore, or plain, which may not be converted into a smiling meadow, yielding repeated crops of succulent grasses for the nourishment of innumerable herds of cattle.

Of this fact there are proofs enough in the operations which have already been carried on for a century on the Craigentinny

LIVERPOOL SEWAGE UTILISATION SCHEME.
SKETCH MAP.



M&N Hanhart lith.

Meadows below Edinburgh, and which yield 30 or 40 tons of grass per acre; some parts of these meadows have been recently reclaimed from the sea-shore; near Rugby, where Mr. Lawes found the produce of the soil to be in direct proportion to the quantity of sewage applied; at Mr. Marriage's farm of 300 acres near Croydon, which is almost wholly under sewage and Italian rye-grass (this seems to be the plant to which it has been applied with the greatest success), and where 30 or 40 tons of grass per acre were mown in 1864; upon sea-land below Shoeburyness, where rye-grass having been sown, and manured with sewage, at once became fertile and yielded heavy crops; and the case recently reported in a letter from the secretary of the Metropolitan Sewage Company to the 'Times,' which deserves special notice.

The work was done upon "the Lodge Farm" near Barking, and is thus described by Mr. Morgan, the secretary:—

"Notwithstanding the previously severe weather, a crop of Italian rye-grass was cut in the early part of April and weighed 9 tons per acre. The same plot was cut a second time on the 15th May, the crop weighing 12 tons per acre. On May 4 a crop was taken from the adjoining piece of land which weighed 18 tons per acre. There are some 70 acres of land under irrigation, which, it is expected, will cut six times during the year."

Now, it must be quite clear, that with meat, butter, cheese, and milk constantly increasing in value, the enormous additions to our pasture areas which are sure to result from the reclamation of waste lands, cannot fail to be of great public benefit; indeed this new source of supply, coupled with the increasing consumption, by cattle, of artificial food (such as linseed-cake, rape-cake, cotton-cake, and palm-nut meal) will, we hope, in time, arrest the upward tendency in the value of those indispensable human requirements. The obstacles to be contended against by the promoters of this great scheme are few, the chief one being that which accompanies all new undertakings, namely, prejudice. Fortunately, however, the diffusion of knowledge amongst the farming community spreads almost as rapidly as in every other class; and whilst such men as Messrs. Lawes, Gilbert, J. Chalmers Morton, J. F. Bateman, and Mr. Robert Neilson, form the front rank, led on by so enthusiastic, but at the same time so judicious a captain as Lord Robert Montague, there is little fear for the ultimate success of the undertaking.

The most recent development of the scheme (briefly referred to in our number of last January*) is the one represented in the accompanying plan for utilizing the sewage of Liverpool. This gigantic and philanthropic undertaking will fulfil all the conditions named in the early part of this essay. It will relieve the vast and unhealthy town of Liverpool of one of its chief sources of

* 'Journal of Science,' No. xiii. Agricultural Chronicle.

disease; will provide for the conveyance of the right thing to the right place—will reclaim whole tracts of sand, on which nothing now thrives but broom and rushes, into rich and fruitful meadows; and will set an example that is sure to be followed by other large communities.

From the circular which we have received, it would appear that the promoters of the scheme (and it is already a company incorporated by Act of Parliament) intend to proceed cautiously. At first they mean to collect the sewage, which will become richer and richer every year, in consequence of the changes taking place in the system of defecation at Liverpool, and having first raised it by steam power just outside of the town, to convey it through a system of pipes into the townships of Bootle, Linacre, Litherland, Orrell, Great Crosby, Little Crosby, Ince Blundell, and Altcar, comprising an area of between 18,000 and 20,000 acres, to which the sewage may be profitably applied.

"The engineers of the company estimate the cost of delivering 300,000 gallons of sewage daily as far as Little Crosby, and placing it within the reach of the farmers of about 5,000 acres, at about 12,000*l*. If, however, it was deemed advisable to supply the entire area comprised in the above-named townships, the quantity required would be on the average one million gallons per diem, the cost of which would be about 28,000*l*." "If a branch pipe were carried up towards Maghull, the cost would be increased to 36,000*l*., and the area would be about 26,000 acres. These would comprise the whole of the engineering expenses, but it will be for the subscribers to the company to determine the extent to which the undertaking should be carried at its commencement.

"In the township of Little Crosby, about 2,000 acres of land belong to Major Blundell, who is favourable to the scheme, and has offered to place at the disposal of the company a considerable area intersected by the Liverpool and Southport Railway, on which sewage may be used in order to show the effects produced by its application. The works are designed so as to supply the farmers in the district with such quantities as they may require."

The chief promoters of the gigantic undertaking are Lord Robert Montague, Mr. Bateman, C.E., Serjeant Wheeler, LL.D., E. K. Muspratt, Esq., the Borough Engineer, the Water Engineer of Liverpool; the corporation aids the scheme by supplying the sewage, appoints two of its members as Directors of the Company, and, we believe, will participate in the profits when they attain a certain sum.

But it is not on account of any anticipated commercial advantages which may accrue that we recommend the public to encourage this great movement (and we refer of course not to one particular scheme, but to the National undertaking). Ever since this Periodical

was commenced we have watched it closely, and its development will be found noted from time to time in our Agricultural and Chemical Chronicles. But now it ceases to be an experimental, and becomes a practical National movement, which deserves and will command the sanction and support of every sanitarian, of every agriculturist, and perhaps, before long, of too many needy speculators. Out of evil cometh good, and if the next mania should be for "Utilization of Sewage Company's Shares," and it should even ruin a few here and there, the ultimate result of the periodical attack, should it manifest itself under this aspect, would be beneficial to the great mass of the population.

Let us, however, trust that no such means will be resorted to for pushing the national enterprise; let us rather hope that a growing sense of responsibility on the part of the guardians of health in our large towns, and the anxiety to utilize every foot of land and every blade of grass will contribute to bring about so desirable a change as that now commencing in our sanitary and agricultural arrangements.

It is hardly necessary to add, that the movement will be watched by us in the future, as it has been in the past, with earnest anxiety for its success, and that whenever or wherever any new development may present itself, it will always be hailed with satisfaction and encouraged to the utmost of our limited powers.

VII. THE PROGRESS OF SCIENCE ABROAD.

1. *Sesion Publica, Aniversario vigesimo-septimo del Instituto Médico Valenciano.* Valencia: Imprenta de D. José M. Garin.
2. *Geology and Agriculture.* By E. St. John Fairman, F.G.S., F.R.G.S., &c. Florence: printed by G. Barbèra.
3. *Experimental Investigations connected with the Supply of Water from the Hooghly to Calcutta.* By David Waldie, Esq., F.C.S. From the Journal of the Asiatic Society of Bengal.
4. *Intercolonial Exhibition of* 1866—*Mining and Mineral Statistics.* By R. Brough Smyth, F.G.S. Lond., &c. Melbourne: Blundell & Ford.
5. *The American Naturalist—a Popular Illustrated Magazine of Natural History.* Salem: Essex Institute (Trübner & Co., London).

How apt we all are to confine our observations on every subject to the limited sphere in which we are daily accustomed to move.

The artist rarely troubles himself about the productions of any pencil but his own, or that of his immediate neighbour; seldom does the *littérateur* of one country watch and make himself ac-

quainted with the poetry and drama of neighbouring nations who use a different tongue, unless perchance one or two brilliant gems should have been translated and set in the formal frame of his native jeweller. And so too it is with science. There are busy hands at work in every part of the world gathering up nature's treasures, and thoughtful brains poring over her secrets and attempting to unravel her mysteries; but how little do the men of one land know what those in another are about?

Such of our readers as are accustomed to glance over the list of publications which are forwarded to us for review, must have been surprised from time to time on reading the titles of books and essays which reach us from far distant lands; but all we can do, in the majority of cases, is to acknowledge their receipt, or transfer some novelty from their pages to our Chronicles of Science.

Let us, however, to-day, drink a little deeper of these foreign draughts; let us, for curiosity's sake, glance cursorily over a few of the pamphlets which have just reached us from various parts of the world.

Here we have, first of all, an odd-looking pamphlet, innocent of thread or paste, folded in a remarkable sheet of pink paper for a cover, and printed on rough dark-coloured paper. It is called 'Sesion Pública, Aniversario vigésimo-séptimo del Instituto Médico Valenciano;' then comes a device composed of sundry skulls, stills, books, and a bust, but the engraving of which is so primitive, that we cannot make out whether it is intended for Galen or Æsculapius; and on opening the pamphlet we find it to be the 'Discurso Inaugural pronunciado el dia 31 de Marzo' de 1867, by "D. Norverto de Arcas Benitez," Licentiate of the Faculty of Pharmacy, &c., to the Medical Institute of Valencia. It runs on to nearly ninety pages, treats of almost everything material and immaterial, and whilst its orthodoxy is undoubted, it does not convey anything either new or interesting; in fact, it is essentially Spanish in its character, and, as will be seen from the following statements, permits no biological heresy:—

"1ª. Que el instinto y la inteligencia son espicificamente diferentes.

"2ª. Que por el instinto, el animal se mueve sin conocimiento de causa."* "Que no hay voluntad ni facultades sino en el hombre, como llevo probado, y por lo tanto almo."†

He believes instinct and intelligence to be specifically different; and as to instinct, the animal moves without consciousness; he believes that he has proved that man alone has a will, and proceeds then to show that his soul is immaterial. What say you to that, Shade of Lamarck? and you, oh! Huxley? believer in the imperceptible transition from "blind force to conscious intellect and

* P. 59. † P. 62.

will!" Read Don (or Doctor, we don't know which) Norverto de Arcas Benitez, and forsake the errors of your ways. We confess that *we* are not much flattered by the very small influence that the 'Quarterly Journal of Science' seems to have exercised on the blue blood of the Valentian savant.

From Valencia to Pisa is no great step; and thence we receive, "with the author's compliments," another little pink pamphlet (this time beautifully printed in English, by G. Barbera, Florence), on "Geology and Agriculture," by E. St. John Fairman, F.G.S., F.R.G.S., &c., whose object in publishing his essay appears to be to induce the Italian Government "to help by every means in its power the people to supply the expenses necessary for carrying on the business of the country."* "Agriculture," he says, "is more attended to in Piedmont than in any other part of Italy; but although Sardinia abounds in mountains, mining is little practised, and the mineral wealth of the country, notwithstanding that it is believed to be great, has never been ascertained. In those parts of Italy where the principal occupation of the people is agriculture, it is allowed on all hands that it is not skilfully conducted." † "The Government, aided by men of science, should give their attention to this."

We must now wing our flight to Australia, but on the way let us take a glance at what is doing in India.

David Waldie, Esq., F.C.S., &c., sends us a paper reprinted from the 'Journal of the Asiatic Society' of Bengal, describing his "Experimental Investigations connected with the Supply of Water from the Hooghly to Calcutta."

"The subject has been under the consideration of the municipal authorities of Calcutta, who, as is well known, have organized a scheme for the supply of the town from the River Hooghly, for the carrying out of which arrangements are now in progress;"‡ and Mr. Waldie has arrived at the conclusion that "as regards its organic constituents, the Hooghly water taken near Calcutta is at least as pure as any of the waters supplied to London;" "during the hot season it is mixed with sea-water under the influence of the tides, and thereby rendered brackish; this can be avoided by taking the supply of water from further up the river."§ Well, we suppose in the matter of beverages the good people of Calcutta cannot afford to be over particular; but to us the testimony in favour of the Hooghly water seems to be at least questionable.

The 'Geological Survey of India' send us some more of their magnificent publications, but those we must leave to our Chronicler, and continuing our flight, we will settle down for a moment or two at—

Melbourne, whence Mr. R. Brough Smyth, F.G.S., sends us

* P. 5. † P. 6. ‡ P. 1. § Pp. 32, 33.

some mining statistics of the Colony of Victoria. The progress of mining in the Colony is indicated in the following extract, and the pamphlet contains an exhaustive description of what is doing in the various mining districts:—

"In the prefatory Essay on Mining in the Colony of Victoria, which was published with the Catalogue of the Victorian Exhibition in 1861, it was stated that the labours of the miners were confined almost exclusively to the working of, and the extraction of gold from, the auriferous rocks. It was observed that the extraordinary richness of the goldfields, absorbing nearly all the available labour in the country, had to some extent prevented the exploration of the deposits of tin, antimony, iron ore, and coal; and a hope was expressed that in a short time other minerals and metals as well as gold would attract the attention of the capitalist, and that new fields would be explored and fresh sources of industry opened up to the intelligent miner, which would afford employment to a great number of persons. This hope has not been disappointed. Whilst the yield of gold per annum has not fallen off, if we make proper allowance for the reduction in the number of miners, other minerals have been eagerly sought for, and large areas of country have been prospected, and in some parts thoroughly explored.

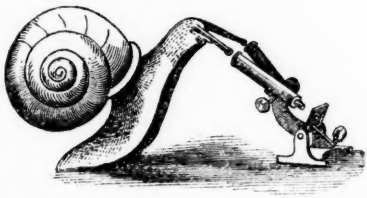
"From St. Arnaud we have obtained silver; from Beechworth and the heads of the Latrobe, fresh supplies of tin; from the River Thompson, in Gipps Land, copper; from Heathcote, large quantities of antimony; from Cape Paterson, coal; from Lal Lal, near Ballarat, lignite; from Omeo, bismuth; from Yackandandah, molybdenite; from Pleasant Creek, the Upper Yarra, and other localities, manganese; from Bulla and Dunolly, clays suitable for the manufacture of the finer kinds of porcelain; from Castlemaine, magnesite; from Maldon, Castlemaine, and Meredith, roofing slates; and from Beechworth, diamonds.

"If all these are not fully represented in the tables, it is not less certain that they occur; and that in due time they will add greatly to the wealth of the country. Gold mining, however, continues to be profitable; and it is not probable that experienced miners will forsake the search for gold, in order to engage in other mining operations which do not offer sure prospects of success, so long as rich quartz reefs and auriferous alluvions lie neglected."

Commending the industry of Mr. Smyth, we once more flap our wings, and sailing through the sky for many a weary day, we alight at length at the door of the 'Essex Institute,' Salem, Mass. The directors must not be offended with us for enlightening our readers as to where Salem is, inasmuch as they set us the example, by informing the readers of their new and beautiful journal, 'The American Naturalist,' that it may be obtained from Messrs. Trübner & Co., London, *England*.

It is a beautiful periodical, and as we read its introduction, we have great hopes of its permanent success. It ends thus :—

"The editorial responsibility seems great, and nothing but the boundless wealth of nature spread out before us, the untiring good will of our scientific friends in contributing to our pages, and the promise of the kindly appreciation of the public, can be an excuse for our appearance, and for any apparent presumption in our bearing."



Whether or not the little cut is meant to represent the "appearance" of the Editor, we are at a loss to explain; but we do hope that it is not intended to illustrate the mode of progression of the scientific world in America, or we should have to recommend our friends to exchange with the 'Instituto Medico Valenciano,' rather than with us. But as we have said, it is a beautiful periodical. The first two parts contain some valuable and well-illustrated papers. Amongst these we commend to the general reader (in No. 1) Mr. W. T. Brigham's visit to the volcano of Kilauea, Hawaiian Islands, in 1864–65 :—

"Boston could easily be accommodated within this crater, and Vesuvius would not much more than fill it."* "As we were sitting on the brink, a shrill shriek broke through the night air. We could see the black walls of the crater all around us, and between us and the pathway leading out, a line of watchfires, and I was quite as much impressed as my natives with the direful stories they had been telling me. The shriek was repeated, and it was evidently the utterance of a human being in great agony. Lighting the lantern we had brought for any emergency, we went slowly towards the place, until the shriek was uttered at our very feet. We hastily examined the cracks and called, but there was no answer, and all was still. We looked everywhere, finding no one, and turned to go back, thinking some poor kanaka, venturing down in the dark, had fallen into some crack, and at last died.

"We had gone but a few rods when the shriek was repeated. The natives clung to me in mortal terror, but I insisted on going back, and placing the lantern on a rock, we sat down to await developments; it seemed as though the question, 'Are there any

* P. 17.

spirits present?' was quite superfluous. We sat more than five minutes in silence, and I could feel the poor fellows tremble as they sat close up to me. Then the shriek was repeated, but we saw the spirit that made it—a jet of steam—and my boys were encouraged."*

The crater may be correctly depicted in the plate, but it is not well executed.

On technical subjects we have beautifully illustrated papers on "The Land Snails of New England," by E. S. Morse (Nos. 1 & 2); "The Moss Animals or Polyzoa," by A. Hyatt (No. 2); "The American Silkworm," by L. Trouvelet; also, "The Fossil Reptiles of New Jersey," by Prof. E. D. Cope (No. 1); "Winter Notes of an Ornithologist," by J. A. Allen (No. 1); and "The Fertilization of Flowering Plants."

The leading men of science in America are amongst the contributors to the 'American Naturalist,' and it is in every way worthy of the great nation which it is intended to interest and instruct.

And now we must close this brief notice of a few of the pamphlets and periodicals which find their way to us from every quarter of the globe. The motley collection may have induced us to smile a little over their appearance, but not the less do we value their contents. They betoken a growing spirit of research all over the world; and the very delivery of an Inaugural Address in Valencia, and the publication of a charming popular periodical on Natural History in Salem, Mass., are evidences of the spread of scientific knowledge; of an increasing taste for the study of nature and her laws; and we should feel grateful to Providence, that, through this interchange of thoughts between nation and nation, between mind and mind, we are permitted to obtain a glimpse of an ever unfolding, ever spreading Wisdom, destined one day to illuminate the whole world.

* P. 22.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

The Cattle Plague is still one of the leading agricultural topics. Its reappearance in the London cowhouses within the past few weeks, after so long an interval, has startled us all; and Agricultural Societies, believing that it is the result of an imported poison, are urging upon Government the need of altogether forbidding the landing of live cattle from the continent, or at least of killing all fat stock at the port of debarkation, allowing milch cattle and other stock in "store" condition to leave only after a sufficiently long quarantine. During the last weeks of May the disease, which had since January altogether left the metropolis, reappeared in many cowhouses in the east and north of London; and in several cases large herds have been swept away; the virulence of the attack being just as great as ever. No fewer than sixty cows in one herd of ninety-five were taken in three days from the first detection of a symptom, and the whole were then slaughtered; and the same fate has overtaken several other stocks. The whole of the cattle grazing on Wormwood Scrubs, for example, have been thus disposed of: and it is to be hoped that the severity of the measures which have been adopted may hinder the further extension of the malady. No attempt at cure has hitherto succeeded. Mr. H. Dixon, who has as large and particular acquaintance with English herds as any man, relates in the current number of the English Agricultural Society's journal the few examples known to him of any attempt to deal with the disease. His evidence amounts to little more than that isolation has saved many a herd that was in danger, and that remedies have done hardly anything whatever. Thus, Mr. Davies, of Cheshire, had saved his herd for some months by using chlorine gas constantly in the houses, and hyposulphite of soda in the water given to the cattle; sawdust, too, was used as litter, being more cleanly than straw; but whether the safety of the stock was due to mere isolation or to this disinfection of their houses and this medication of their food cannot be certainly declared. It was not, however, until they had been turned out to the pasture field that they were attacked, and then many of them died. An iodine ointment rubbed on the chest and acting as a counter-irritant, served in two or three cases to give relief when applied early enough; but in only nine cases out of thirty-six did the patient recover. Mr. Aylmer, of Norfolk,

tried chloroform: of ninety head, five died before treatment, six were not attacked, and no fewer than forty-one recovered. Full-grown beasts had an ounce of chloroform administered to them each time, calves a quarter of an ounce, and others in proportion to their age. A saturated handkerchief was simply put in a bag, which was hung close under the nostrils and tied by a string behind the poll. Five to seven minutes was generally enough to produce insensibility, and the cattle were kept under its influence for periods of from half-an-hour to two hours. Seven or eight doses generally effected a cure; and they seem to have been administered twice a day. The immediate effect was to sweeten the breath of the animal, the inflammation and fever were reduced, and unless these returned within the day, the case was hopeful. The result of all was that in July, the disease having appeared in April, "Mr. Aylmer found himself with a clean bill of health and with upwards of 50 per cent. of those which had been treated alive and well in their stalls." Notwithstanding, however, the few examples of treatment which seem, like this one, to have afforded some encouragement, it is still almost universally admitted that our only preventive is to be found in isolation, and our only hope of safety in immediate slaughter.

The journal of the English Agricultural Society contains in its current number a large mass of very valuable information on the subject of steam cultivation. It has been long admitted that a tool drawn across the land and stirring the soil or ploughing it to its full depth, without trampling it and poaching it as horses do when they are the power employed, must be greatly improved in its efficiency as a tillage implement. Experience has perfectly established this wherever the thing has been put to the test on clay land; and many a clay-land farm which could not formerly be cultivated except during short intervals of suitable weather, and then only by a staff of horses which must be kept all through the year for the purpose, has since been a standing advertisment of the superiority of that cultivation by steam power, which could be thus rapidly accomplished during the short intervals when alone clay land ought to be touched, and which at the same time involved comparatively little expense when the tools employed lay idle. It was, however, still generally feared that the cost of steam cultivation was excessive, and either beyond the means of ordinary English farmers or so much in excess of the ordinary experience of horse tillage as to be dearly bought. The large number of instances collected by the Society's commissioners has now sufficiently cleared up whatever was debatable on the subject. They were instructed to investigate not only the depth and character of steam tillage and the improvements it effected in soil and subsoil, but also the detail of the expenditure incurred—the annual expenses connected with

it in tear and wear and breakages, and all the other drawbacks to the system. And the conclusion arrived at is for the most part extremely encouraging and will no doubt promote the adoption of all the rival plans of carrying out steam cultivation under the various circumstances appropriate to each. On light soil as well as heavy, the advantage of prompter, cheaper, and more thorough work done by steam power has been perfectly demonstrated.

Since the publication of the report the subject has received prolonged discussion at an unusually full meeting of the Agricultural Society; and it was declared that the advantage of steam cultivation amounted on average soils to at least eight bushels per acre in the produce of the grain crops—that arable culture is by means of it annually becoming both cheaper and better—that the drainage of clay soils is facilitated—that while the direct system of traction adopted by Messrs. Fowler and Co. is the best for large fields and large farms, yet the cheaper round-about-system with a stationed engine and windlass is perfectly satisfactory — that even when coals cost 20*s.* a ton, the power obtained from 6*d.* worth of them is equal to the day's labour of a horse—and that the system wherever it is adopted is improving all the classes interested in agriculture, and is thus establishing on a more satisfactory basis the relations amongst landlord, tenant, and labourer.

The revelations made in a recent Blue Book, of the abuses to which the gang system of employing children in the field has given rise, have excited an interest during the past quarter. In recently enclosed districts, the cottage accommodation is especially deficient. Labourers live in widely separated villages, and the labour of boys and girls in the fields being needed on arable land, they have to walk many miles to and from their work, and, being employed at particular seasons on different farms from their parents, and thus collected in bodies under gang-masters, they are liable to all the risks which association with the vicious among themselves and subjection to an unfit foreman sometimes entail upon them. So much feeling has been excited on the subject, that it is probable some legislation may ensue, limiting the age at which girls and boys shall be employed in this way, as well as the distance from their home beyond which they shall not be allowed to work. The condition of the agricultural labourers which has thus been forced upon our attention by a Royal Commission, is also being urged on public notice by themselves. At Gawcott, in Buckinghamshire, there has been a strike amongst them for higher wages, apparently a perfectly spontaneous act, which has, we believe, resulted in the men out of work being gradually drafted off to other districts at better paid employment; and at Halberton, in Devonshire, the same process has been going on, organized and carried out by the clergyman of the parish, to the great annoyance of the employers.

XUM

Though, however, in these two cases, the process has obtruded itself on public attention, it must not be supposed that it is only here that it has been in operation. Almost everywhere the gradual rise of wages in agricultural districts is in progress. Young men refuse employment at the current rate, and go elsewhere for work, and employers are forced to pay a larger sum to their successors. In this way, we may hope that the improved condition of the labouring class will gradually extend, and better cottages and greater comforts will be offered to retain the hands that farmers need. In some few instances, attempts have been made to introduce the co-operative system into agriculture. Labourers have been offered a share in the profits of the business; the capital of the employer receiving a fixed annual sum as interest, the labour of the workman receiving a fixed weekly sum as wages, and the surplus, if any, being divided according to a proportion mutually agreed upon between the two. This system is less likely to gain ground in farming (where so many risks are run, and where the surplus may be sometimes large and sometimes less than nothing) than it is in trade or manufacture, where the risks being less, the returns are much more uniform. Any attempt, however, to attach to one another the various classes interested in agriculture is praiseworthy, whether it be organized in this way or, better still, be the fruit of personal relationship and friendship between the employers and their workmen, and their families one by one.

The subject of emigration, hitherto discussed chiefly in connection with an over-population of the labouring class, has during the past quarter been the subject of a lecture before the London Farmers' Club, in connection rather with our surplus numbers in the class of agricultural employers. And the Rev. G. Smythies has thus pointed out to farmers and their families the opening that exists in the United States, in Canada, at the Cape, in Australia, and in the countries adjoining the River Plate—the opportunities for a prosperous agricultural career, where a smaller capital with the necessary industry and skill will suffice to produce a better income than can be obtained from farming here. A work by Mr. Latham, for many years resident near Buenos Ayres, in which the agricultural advantages of that neighbourhood have been impartially related, has been lately published by Messrs. Longman, and it is significant of the overflowing numbers in the upper agricultural class, that the whole edition has met with an immediate sale.

Among the agricultural publications of the past quarter, we must not forget the volume by Dr. Sellar and Mr. H. Stephens, of Edinburgh, on "Physiology at the Farm in aid of Rearing and Feeding Live Stock" (Blackwoods), which well deserves to be widely studied by the farmer, as a clear and satisfactory exposition of the Physiology and Chemistry of nutrition, and a description of the

methods by which agriculturists may turn the information thus given, to account in practice.

The Proceedings of the Society of Arts must not be forgotten in our Chronicle. At Mr. Harry Chester's suggestion, an energetic Food Committee of that body has been employed in collecting and disseminating information on the importation, marketing, preservation, cookery, &c., of all kinds of meat—on the nature of the milk trade by which London is supplied, and on the supply of milk in country districts—also on the economical possibilities of the flour manufacture. A very useful mass of facts has been thus collected, which must ultimately exert good influence on the various departments of the trade in food. Professor John Wilson, of Edinburgh, has called attention, through this committee, to M. Mouriés' plan of dealing with wheat, by which only the outer cuticle of the grain, containing nothing that is digestible as food, is removed. The bran, which is at present taken from the flour, contains no less than 15 per cent. of useful nitrogenous ingredients, and is itself 15 per cent. of the whole grain. The cuticle which M. Mouriés removes is only 4 per cent. of the wheat, and it is not only worthless as food but, owing to its absorbent nature, it is absolutely mischievous, by increasing the difficulty of storing and keeping the grain. The decorticated grain will pack closer, keep better, and yield a larger quantity of more nutritious flour than the whole wheat dealt with as it is by the ordinary English miller.

Yet another matter connected with the Society of Arts has to be reported. It has offered a handsome prize for the best account of harvest process in this and other countries:—"Whereby cut corn may be protected from rain in the field; whereby standing corn may, in wet seasons, be cut and carried, for drying by artificial process; whereby corn so harvested may be dried by means of ventilation, hot air, or other methods, with suggestions for the storage both in the ear and after thrashing; and whereby corn, sprouted, or otherwise injured, by wet, may be best treated for grinding or feeding purposes." The whole must be supplemented by a statement of the practical results, and of the actual cost of each system described; and authenticated estimates must be given of any process proposed for adoption, based upon existing, possibly incomplete, experiments.

The probability of drying grass artificially, except at an expense which will make the process unprofitable, is not very great; nevertheless, it seems that if the data of the books can be realized in practice, the thing is possible, and, if so, the smaller quantity of water contained in ripe grain, and the greater value of the remainder when the water has been dried off and the crop is ready for storage or for market, should make the artificial process of drying grain crops quite successful. It is probable that 100,000,000

grains of water must be driven off from grass to make two tons of hay, or to dry a fair grain crop off four acres of land. To carry this quantity off in vapour will need 10,000,000 cubic feet of dry air, at an ordinary summer temperature; but if the air were heated artificially to 212°, and the water were thus converted into steam at the boiling point, not more than 400,000 cubic feet would be needed to carry it away. Or, supposing that the air was heated up to nearly 212° and could be removed saturated before it had cooled down below 140° in the process—thus carrying off a full load of water at that temperature, then about 1,000,000 cubic feet would be required to make ready for the rick two tons (say 8*l.* worth) of hay, or five acres (say 50*l.* worth) of a wheat crop. We are told in books that 1 lb. of coal will boil off 6 lbs. of water, and if so, we ought to be able with one ton of coal to heat (sufficiently) enough of air to carry off the water which exists in the quantities of grass and corn respectively which have been named. It is to be hoped that the prize offered by the Society of Arts may elicit the results of some satisfactory experiments in connection with this subject.

Among the principal agricultural facts of the past quarter are the extraordinary prices which have been commanded by pure bred short-horn cattle. Mr. Betts's small herd of "Grand Duchesses"—thirteen cows, bulls, and calves—descended from cows of the late Kirkleavington herd bred by Mr. Bates from "Young Duchess," a cow bought at Charles Colling's sale in 1810, have realized at a sale by auction 5,759*l.* 5*s.*, or 443*l.* a piece. Other families of pure short-horn blood have fetched from 130*l.* to 560*l.* a piece at the sales of Mr. C. L. Betts, near Aylesford, Kent, and of Mr. D. MacIntosh, near Romford, Essex. Sixty-three animals of all ages at the former sale made 180*l.* 19*s.* each, and fifty-seven animals of all ages at the latter sale made 116*l.* a piece; and thus Mr. Strafford the auctioneer, sold on two successive days 120 animals of all ages, for 18,000*l.*, or 150*l.* a piece.

An important lecture by Dr. Voelcker before the English Agricultural Society, on the relations of food and manure, throws light on the economics of an important branch of farm practice. The various food constituents were declared to succeed one another in the order of value according to the following list:—

1. Ready-made fat, *i.e.* oil.
2. Starch, sugar, pectin.
3. Young cellular fibre.
4. Albumen, gluten, casein, &c.
5. Mineral matter.
6. Woody matters, which are of little or no value.

But the money value of purchased food depends not only on the actual nutritiveness of the material, but also on the value of the fertilizing matters which pass through the animal into the manure.

Dr. Voelcker estimates that rape cake yields in the manure 4*l.* worth of ingredients for every ton consumed; cotton cake no less than 5*l.* 6*s.* worth per ton of matter in the excrement; linseed cake 3*l.* 15*s.* per ton; beans and peas about 3*l.*; while other feeding substances possess but little worth as regards their fertilizing value. Rice meal, for example, yields but 1*l.* per ton to the dungheap, and molasses hardly anything at all. It is plain that facts of this kind must for the future materially affect the judgment which will guide the choice of purchased food by the farmer.

We have to report that the English Agricultural Society has at length resolved upon confining within professional limits those educational efforts which its charter binds it to make. Hitherto the small contribution made by it in this direction has gone merely towards the granting of prizes to country boys who pass the best examination in branches of general education before the University examiners. Hereafter whatever it may grant will be devoted to the reward of professional studies alone; and some stimulus may thus be given to the work of professional agricultural education, which it has hitherto almost entirely ignored.

We must not close our record without a word upon the Paris Exhibition, to which we had anticipated devoting a large share of our space. The grand programme put forth by the Commissioners has almost entirely failed so far as agriculture is concerned. The periodical exhibition of live stock and of implements at work, which was part of the original scheme, has not been carried out as intended. The display is confined to a mere show of implements by the agricultural machinists of this and other countries, and there is no particular novelty calling for remark. We can only report that in the agricultural department a very small contribution is made to that wonderful general effect which is now commanding such universal admiration.

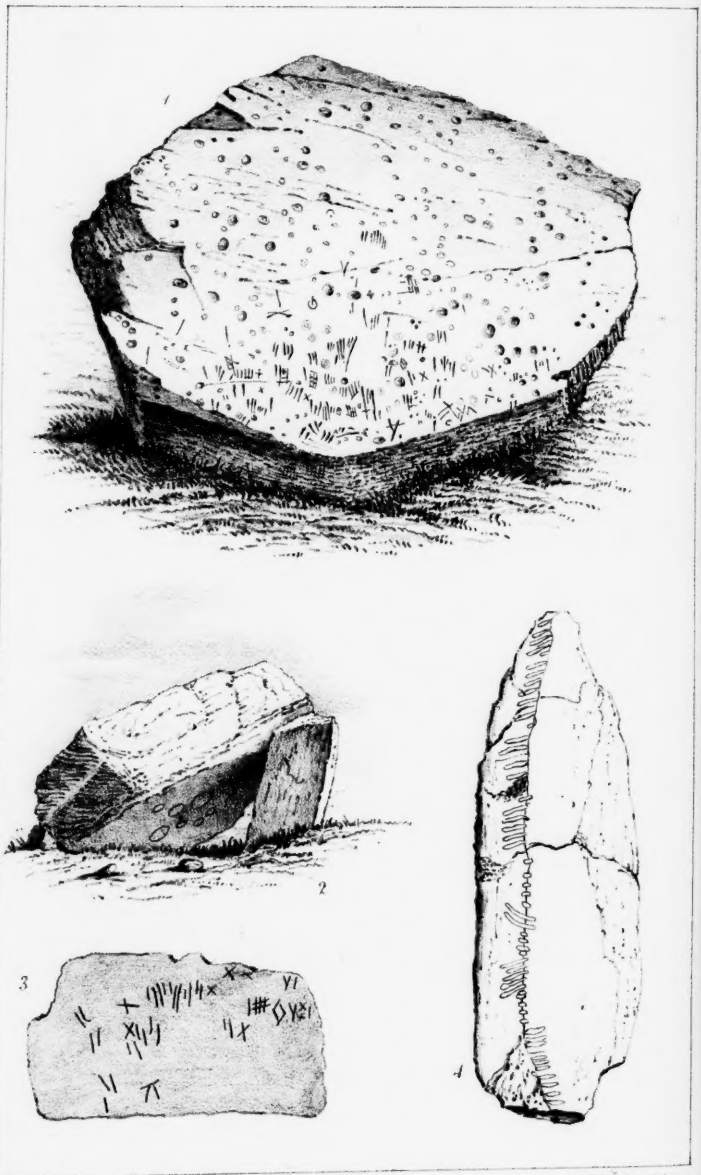
2. ARCHÆOLOGY AND ETHNOLOGY.

We have this quarter to notice a most exhaustive treatise on ancient writing, by Professor J. R. Stephens, of Copenhagen, entitled "The Old Northern Runic Monuments of Scandinavia and England." Although published in Denmark it is written in the English language, a fact which seems highly flattering to us as a scientific nation. Runes, according to Professor Stephens, "appear at the close of the Roman period, and were employed by the 'Barbarians' who overturned the Roman and Keltic systems." The Kelts "brought with them their Ogham staves and the Romans their alphabet, so the 'Barbarians' brought with them these their native characters." Runic

writing, therefore, belongs to a rather later period than that usually termed Pre-historic—to which we usually confine ourselves; but, as will be seen presently, inscriptions have recently been found on cromlechs, which may have some light thrown on them by a study of Runic lore; therefore we have thought it right to call attention to this masterly publication. Respecting the Oghamic inscriptions, to which we shall have further occasion to refer, Professor Stephens remarks, "First and earliest, in my opinion, are the monuments bearing the Ogham-marks. Some 300 of these pillar-stones have been found in Ireland, which country bears the same relation in this respect to the other Keltic lands as Sweden does to the Northern as to the Runes. The great mass of the Ogham stones is in Ireland, the great mass of the Runic stones is in Sweden." Thus, we suppose, the Irish Kelts were at one time the most civilized people in Europe. As an example of their writing we have reproduced a figure (Plate, Fig. 4) of an Ogham stone from Dunbel, Kilkenny, the characters on which have been interpreted to mean "Sacred stone of Eochaidhe of the Excavations." The student must consult Professor Stephens's work to be able to appreciate its importance and interest, and to learn what light Runic writings throw on doubtful points of history and tradition; but some idea of the difficulties which the author has surmounted may be gained by our stating that he has tabulated and correlated upwards of fifty distinct Runic alphabets.

In the 'Proceedings of the Royal Irish Academy,'* which has been published during the past quarter, are some important archæological papers by Mr. E. A. Conwell. The first is an abstract of his account of an "Examination of the ancient Sepulchral Cairns on the Loughcrew Hills, County of Meath (Part 1)," which gives just sufficient details to excite curiosity and interest. These cairns are thirty in number and vary considerably in form, dimensions, and completeness. Of some, very few stones are left, those missing having been apparently quarried away within a comparatively recent period. Taking the one marked H as being of perhaps the greatest interest, we find that its remains are between five and six feet in height and eighteen yards in diameter. The covering of the interior chambers has disappeared, with the exception of about half a dozen large overlapping flags, which are still to be seen in their places over the western and northern crypts, and give a good example of the mode of roofing. The plan is cruciform, the central chamber being a rude octagon. From the passages and crypts the author collected several hundred portions of human bones and skulls, fourteen separate teeth, and eight portions of jaws with teeth remaining. He also obtained a remarkable collection of bone implements (4,884 pieces); beads of amber, glass, and bronze; with

* Vol. ix., part 4.



De Wint. lith.

M & N Hanhart imp.

ANCIENT IRISH INSCRIPTIONS.

rings and a few tools of iron. In this cairn are five inscribed stones. Several of the cairns contain inscribed stones, and the author gives a classified list of the characters on them, to the number of 1,393 separate devices, or many times more than had been previously supposed to exist in Ireland. Mr. Conwell does not indicate the age of these cairns, nor the nature of the inscriptions, except in recording the occurrence, amongst the latter, of "nearly 300 single straight lines, some of which may probably be Oghamic."*

Passing by a paper on an obelisk on Tarra Hill, supposed to be the "Lia Fail," or "Stone of Destiny," on which the Irish kings were formerly crowned, we come to an important memoir by the same author "On an inscribed Cromleac near Rathkenny, Co. Meath." The inscribed stone exhibits on its upper surface a most interesting series of lines, consisting of upwards of ninety separate characters (see Plate, Fig. 1), still showing "the original clean and smooth cutting—for the most part in a triangularly shaped hollowed line—some to the depth of nearly a quarter of an inch." On the under side seven circles are cut (see Plate, Fig. 2), and as many more are visible on the opposite face of an upright stone against which it leans. The sculpturing of the circles is rude, and bears a strong contrast to that of the lines. On the same surface of the slab as the latter are upwards of 300 depressions or cup-shaped hollows, which are probably the result of weathering and not artificial (see Plate, Fig. 1). Mr. Conwell does not attempt to give the meaning of the inscription, nor does he hint at the style of writing to which it may possibly belong. We may remark, however, that in the prevalence of simple lines it has an Oghamic affinity, while a few characters have a somewhat Runic appearance. To show that this is not the only example of such an inscription, Mr. Conwell has reproduced a tracing of one on a cromleac near Macroom, County Cork; and as we have copied this figure also (Plate, Fig. 3), our readers will perceive the striking similarity of the two inscriptions.

The Royal Irish Academy has also published† a valuable memoir by Capt. Meadows Taylor "On Cairns, Cromlechs, Kistvaens, and other Celtic, Druidical, or Scythian monuments in the Dekhan." It would occupy a Chronicle to describe these remains, so we must content ourselves with recording the author's summary of his discoveries. These are, "(1) Cromlechs, or open monuments, with and without circles of stones, containing no remains; (2) Kistvaens, with and without circular perforations in a side-slab, and with and without covering slabs, containing human ashes, bones, and broken pottery; (3) Cairns and barrows, with single, double, and treble circles of rocks and stones, containing cists and skeletons, with traces of human sacrifice, pottery, arms, &c.; others with cinerary urns

* For an example of an Oghamic inscription, see Plate, Fig. 4.

† Trans. Roy. Irish Acad., vol. xxiv., part 5.

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interred in them without cists; (4) Rock-temples, with circles of stones round them; (5) Lines of rocks placed to mark boundaries for cairns; (6) Square and diagonal platforms of rocks enclosing cairns; (7) The great parallelogram and place of cremation at Shahpoor." These embrace nearly all the known forms of Druidical or Scythian remains, and the author therefore concludes that they establish the identity of the great Aryan nomadic tribes of the east with those of the west. The almost perfect similarity of the monuments of worship and sepulture in the two regions is evidently too remarkable to be doubted. Indeed, Capt. Taylor, in a subsequent paper on "A Group of Ancient Cairns on Twizell Moor, in Northumberland," points out that these agree in very minute points with those he had previously described as occurring in India. These two papers are worthy of careful study by the philologist as well as the antiquary, for if the remarkable similarity between the Cairns and Cromlechs of England and those of India really bear the interpretation suggested by the author, the existence of the people termed Aryan by the philologist is no longer a mere theory, *pour servir*, but is an historical truth.

In Part IV. of the 'Reliquiæ Aquitanicæ' is a discussion by the late Mr. Christy on the antiquity of the Reindeer-period in Southern France,—a question of considerable difficulty with regard to dates, but comparatively easy if the object be merely "to indicate its place in the series of observed facts in relation to ancient man." Mr. Christy is doubtless correct in stating that it is "of higher antiquity than the Kjökkenmöddings of Denmark and the Lacustrine dwellings of Switzerland, and very certainly than the whole group of so-called Celtic and Cromlech remains." His other conclusion "that, so far, nothing in the investigation of the works of uncivilized or primitive man, either of ancient or modern times, appears to necessitate a change in the old cherished idea of the Unity of the Human Race," will probably be called in question by many. Indeed, it is not by any means an accepted principle that a similarity of design in certain of man's works is any sure indication of unity of origin. Therefore, although it is probable that the conclusion is true, it is neither confirmed nor controverted by the evidence here brought forward.

Amongst the specimens figured in this part are two hollowed pebbles of granite, the use of which is very doubtful, unless they were mortars, and there are difficulties in the way of even this interpretation.

The 'Anthropological Review' for April contains several articles of considerable interest, including the commencement of two of a general character, which will well repay perusal, namely, Dr. Broca on Anthropology, and Prof. Carl Vogt on "The Primitive Period of the Human Species." There is also a paper by Dr.

Robert H. Collyer on "The Fossil Human Jaw from Suffolk," in which the author quotes the opinions of several eminent osteologists as to the age of this famous "Coprolite Jaw." Mr. Busk, who has most carefully examined it, states that "though not of the portentous antiquity it would have claimed, had it been cotemporary of *Elephas meridionalis*, the 'coprolite jaw' fairly claims a considerable age." The beds at Foxhall, near Ipswich, from which the jaw was said to have been obtained, belong to the coprolite-yielding Red Crag, and *are* of the age of *Elephas meridionalis*, so clearly Mr. Busk thinks it is of posterior date. Mr. Collyer, however, observes that "when he [Mr. Busk] says the coprolite jaw is of very great antiquity he admits the whole question."

The 'Journal of the Anthropological Society' contains an interesting paper by Lieut.-Col. Lane Fox, entitled "A Description of certain Piles found near London Wall and Southwark, possibly the remains of Pile Buildings." The bones found with the piles at London Wall belong chiefly to domestic animals, but mixed, according to Mr. Carter Blake, with a cave-species of goat (*Capra pyrenaica*) and with two extinct species of ox, viz. *Bos longifrons* and *Bos trochoceros*. The works of art associated with them were, curiously enough, partly Roman, and partly of a ruder construction, namely, "handles and points of bone," which, in the opinion of Professor Owen and Mr. Blake, "may possibly have been formed with flint;" but Col. Lane Fox has been unable to ascertain that they were found at a lower level than the Roman remains, or that any flint implements have been found in the place. Still, to whatever period this mixture of remains may belong, the occurrence of traces of pile-dwellings in the valley of the Thames is a fact of very high interest.

There is also a paper by the Rev. Dunbar Heath "On the Way in which Large Bodies of Mute Men would acquire Language from Small Bodies of Speaking Men."

Almost simultaneously with the discovery of pile-dwellings in London has appeared the announcement of the finding of flint implements, associated with the remains of living and extinct species of mammals, in Paris. Amongst the mammals are *Elephas primigenius*, *Elephas antiquus*, *Rhinoceros tichorhinus*, *Hippopotamus amphibius*, *Bos primigenius*, *Bos taurus*, *Cervus Canadensis*, *Cervus elaphus*, &c. Further details are given in two papers in the last number of the 'Bulletin de la Société Géologique de France,'* namely, "Recherches archéologiques et paléontologiques faites dans l'intérieur de Paris," by M. Reboux; and "Sur les instruments humains et les ossements d'animaux trouvés par MM. Martin et Reboux dans le terrain quaternaire de Paris," by M. Albert Gaudry.

* Vol. xxiv., No. 2.

The last volume of the Transactions of the Ethnological Society contains so large a number of papers that we can notice only a selection from them. In Mr. Crawford's paper "On the Physical and Mental Characteristics of the European and Asiatic Races of Man," the author arrives at the conclusion that between these races "there is a broad innate difference, physical, intellectual, and moral; and that such difference has existed from the earliest authentic records and is most probably coeval with the first creation of man." The same author has a paper on the History of Written Language, in which he brings forward his theoretical views on the subject, some of which appear scarcely in unison with facts. He endeavours to show that written characters were used in Asia long before they were in Europe; and he states that in the time of Julius Cæsar our ancestors were "as illiterate as are now the negroes of Ashantee, or as were the cannibals of New Zealand when Cook first described them." His argument appears to be that in Asia every nation has its own written alphabet, and sometimes more than one, except where that of some other nation has superseded the original one, while in Europe the Greek and Roman characters are in universal use. Indeed, he states that "no race from the Euxine to the Atlantic, or from Greece to Scandinavia, has ever invented an alphabet." Does not Mr. Crawford know that the Roman alphabet superseded the Runic in Scandinavia and England, that the Ogham staves of Ireland are still older, and that other phonetic writings have been discovered whose age and meaning are as yet unknown?

Sir John Lubbock and Mr. Frederick Lubbock, in a paper "On the true Assignation of the Bronze Weapons, &c., found in Northern and Western Europe," defend with considerable success the antiquity of the weapons of the Bronze age, in contravention of Mr. Wright's theory that they are of Roman origin.

Mr. Wright has a paper "On the Intercourse of the Romans with Ireland," in which he shows that authentic discoveries of Roman coins have been made in five Irish counties, and all, with one exception, in the province of Ulster. Professor Steenstrup and Sir John Lubbock describe the Flint Implements recently discovered near Pressigny-le-Grande; Mr. Crawford has three papers "On the History and Migration of Cultivated Plants in reference to Ethnology;" and Mr. R. Dunn contributes an article entitled "Archæology and Ethnology: remarks on some of the bearings of Archæology upon certain Ethnological Problems and Researches;" but these and some other papers of interest we have no space to discuss.

A noteworthy paper by Dr. Faudel, "Sur la découverte d'ossements fossiles humains dans le lehm de la vallée du Rhin à Eguisheim, près Colmar (Haut Rhin)," has been published this

year in the Bulletin of the Colmar Natural History Society. The human bones consist of a frontal and a right parietal, almost entire, belonging to the same skull; and they were found associated with remains of the Bison, *Elephas primigenius*, &c., in the Lehm or Loess of the valley of the Upper Rhine. From their discovery the author infers that man existed in Alsace prior to those changes which, coming after the deposition of the diluvium, gave to the country its present outline.

An International Congress for Anthropology and Prehistoric Archæology is announced to be held in Paris, under the Presidency of M. Lartêt, from the 17th to the 28th of August inclusive.

EXPLANATION OF THE PLATE.

Fig. 1. Inscribed slab of a cromlech near Rathkenny, Co. Meath; copied from the Proceedings of the Royal Irish Academy, vol. ix., plate 12.

Fig. 2. Side-view of the inscribed cromlech near Rathkenny, Co. Meath, showing the inscribed circles on the under surface of the inclined slab (Fig. 1), copied from the Proceedings of the Royal Irish Academy, vol. ix., plate 11, Fig. 4.

Fig. 3. Tracing of an inscription on a cromlech at Macroom, Co. Cork, copied from the Proceedings of the Royal Irish Academy, vol. ix., plate 11, Fig. 3.

Fig. 4. Ogham Stone from Dunbel, Kilkenny, copied from Professor Stephens's 'Runic Monuments,' part 1, p. 57.

3.—ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

Observation of the meteor-shower of last November, and a careful discussion of the phenomena, have resulted in one of the most interesting discoveries which has for many years been effected by astronomers. In our last Chronicle we pointed out that the want of observations determining the velocity with which the meteors travelled, left us, apparently, no choice but to select the most probable period of revolution, out of several which accounted for the observed recurrence of maximum displays. For reasons there discussed, astronomers selected a period falling short of one year by one-33rd part. The most natural explanation of the well-marked period of 33¼ years—the supposition, namely, that this interval is the true period in which meteors complete a revolution around the sun—was looked on as far less probable. The objections to this view are:—(i) The *à priori* improbability that an orbit of such eccentricity as the supposition implies, should intersect the earth's orbit; (ii) the further improbability that the intersection should fall so near the perihelion of the meteor's orbit as to account for the position of the radiant-point; and (iii) the difficulty of conceiving that an orbit of such extent should be so plentifully

bestrewn with meteors as to give a yearly recurrence of showers besides the great displays occurring at intervals of $33\frac{1}{4}$ years.

Leverrier, however, calculated the orbit on the supposition of a period of $33\frac{1}{4}$ years. It is easily shown that the orbit has a mean distance exceeding that of Saturn; and that, owing to its eccentricity, its aphelion extends beyond the orbit of Uranus.

But the difficulty lay in deciding between this orbit and that adopted provisionally by Professor Newton, and supported by the strongly-expressed opinion of Sir John Herschel. There was but one phenomenon available for the decision of this question—but the consideration of this phenomenon brought the question immediately into the class of the abstrusest mathematical problems. On examining the dates upon which the shower appeared in former years, it is seen that these dates fall later and later in the year at each successive recurrence. Thus in the year 902 A.D., when the earliest recorded shower took place, it occurred on Oct. 12th O.S., or Oct. 17th N.S., four weeks earlier than the present date of the shower. This corresponds to an annual displacement of the node of the meteor's orbit by 102″·6, with respect to the equinox, or by 52″·4 with respect to the fixed stars. Now it is possible to calculate the secular motion of the node for an orbit of given period, though the problem has peculiar difficulties, either when Professor Newton's assumed period is taken, or when the eccentric orbit corresponding to the period of $33\frac{1}{4}$ years is considered. Professor Adams has calculated the nodal motion for both cases. In the first case he obtained an annual retrogression of only 21″ instead of 52″·4. In the latter he obtained a retrogression of 28′ in $33\frac{1}{4}$ years, or about 50″·5 in one year, a result according so closely (considering the circumstances) with observation, as to leave no doubt that 33·25 years is the true period of the meteoric orbit.

A result yet more interesting appears to flow from Adams's researches. When the orbit of the meteors is calculated, it appears that its elements agree in the most remarkable manner with those of a periodic comet discovered in January, 1866. The following table exhibits this agreement:—

	November Meteors.	Comet I., 1866.
Period	33·25 years (assumed)	33·18 years.
Mean distance	10·3402	10·3248
Eccentricity	0·9047	0·9054
Perihelion distance	0·9855	0 9765
Inclination	16° 46′	17° 18′
Longitude of node	51° 28′	51° 26′
Longitude of perihelion	57° 19′	60° 28′
Direction of motion	Retrograde	Retrograde.

Close as the approximation appears, it would be yet closer if we assumed (as we are free to do) that the period of the meteors is 33·18 years instead of $33\frac{1}{4}$, a professedly rough approximation.

Singularly enough this particular comet is the only one which

has been satisfactorily subjected to spectrum-analysis. Mr. Huggins found that the nucleus was gaseous, and that the coma was either composed of (finely divided) matter in a state of incandescence, or shone by reflected light. The comet had no visible tail.

Signor Schiaparelli had before noticed that if we suppose the August meteors to describe a very eccentric orbit (as their great velocity entitles us to do), the elements of their orbit, calculated from the observed position of their radiant point, agree very closely with those of the orbit of Comet II., 1862. The following table exhibits the resemblance between the orbits:—

	August Meteors.	Comet II., 1862.
Perihelion distance	0·9643	0·9626
Inclination	64° 3′	66° 25′
Longitude of perihelion	343° 28′	344° 41′
Longitude of node	138° 16′	137° 27′
Direction of motion	Retrograde	Retrograde.

The period of this comet, which it will be remembered was a large and in other respects remarkable one, has been calculated by Dr. Oppolzer to be about 142 years, and the orbit extends into space far beyond that of Neptune.

Dr. Edmund Weise, of Vienna, has pointed out the coincidence of many other observed meteor-tracks with cometic orbits. We conclude the discussion of this interesting subject with his sketch of the process by which the whole orbit of a comet is conceived to be strewn with meteoric bodies, not following each other in one path, but dispersed many thousands, perhaps many millions, of miles on every side of the central track. If we consider, he says, the circumstances under which a comet approaches the sun, we shall see that individual particles must be repelled to a distance where, "collecting under the original laws of aggregation around new centres of gravity, they will revolve about the sun in orbits closely resembling that of the parent-comet. In the case of periodical comets, these dispersed aggregations will gradually collect along the whole orbit, and if the comet's orbit intersect, or approach very near to the earth's orbit, the phenomenon of periodic showers will be produced at the annual passage of the earth through the point of intersection."

Mr. Stone has detected a small error in Leverrier's determination of the Solar Parallax. The error lies in the numerical work. Leverrier's method is (in theory at least) very beautiful, and is little known. The earth has an orbital motion around the common centre of gravity of the moon and earth; the diameter of this orbit being about 6,000 miles. In Leverrier's method the earth's motion in this small orbit is taken advantage of to determine the sun's distance. The size of this subsidiary orbit being determined from the estimated mass of the moon, and the displacement of the sun due to the earth's excursions in her monthly

orbit being determined from a careful examination of a long series of observations, the ratio of the sun's distance to the moon's is determined by a simple calculation. Owing to a mistake in the numerical work, Leverrier took the moon's mass at $\frac{1}{81 \cdot 15}$th instead of $\frac{1}{81 \cdot 45}$th of the earth's. The effect of the correction is to reduce the solar parallax from 8″·95 to 8″·91, corresponding to an increase of upwards of 400,000 miles in the sun's estimated distance. The weak point of the method clearly lies in the great variation resulting from a very small change in the estimated value of the moon's mass. On this account the observations made use of are better fitted for the solution of the inverse problem, the determination of the moon's mass from the earth's parallactic inequality; and, indeed, Delambre has already made use of this method for the purpose named.

The corrected estimate of the sun's distance, by Leverrier's mode, agrees with Hansen's determination from the moon's parallactic inequality. Mr. Stone, who had obtained the value 8″·94 for the solar parallax from observations of Mars, has lately deduced the value 8″·85 (with a possible error of 0″·056) from the Greenwich lunar observations made near the epoch of maximum lunar parallactic inequality. It is to be noticed that when Mr. Stone speaks of the last-named inequality as *corresponding* to the earth's parallactic inequality, he must be understood as speaking merely of nominal correspondence, the two inequalities being quite distinct in character.

During the late opposition of Mars, Mr. Huggins made several observations of the planet's spectrum. As in former observations, groups of lines were seen in the blue and indigo, but it was not found possible to measure these so as to determine whether they are solar or due to the planet's atmosphere. Again, also, many marked lines were seen in the red. On February 14, faint lines were seen near D, and were judged by Mr. Huggins to be due to absorption by the planet's atmosphere, as, although similar to lines seen in the solar spectrum when the sun is low, Mars was not low enough for the production of the lines, which were not seen in the moon's spectrum though she was lower than Mars. The spectrum of the darker portions of the disc was less brilliant than that from the lighter part, indicating equality of absorption, and that the colour of the darker parts is nearly, if not quite, neutral.

Mr. Huggins concludes that the ruddy colour of Mars is not due to its atmosphere, but to the materials of the planet's body; and he remarks that the polar regions show no colour, though the light from them traverses a greater depth of atmosphere than that from the central parts of the disc. This evidence seems conclusive; but Mr. Huggins quotes, as additional evidence, the views of Dr. Zöllner respecting (i) peculiarities in the rate at which the

brightness of Mars varies with varying phase, and (ii) the greater brightness of the disc near the limb. Zöllner ascribes these peculiarities to the slope of elevations on the surface of Mars. Mr. Huggins accepts this view as probable, adding that "it is important to remark in this connection that the darker portions of the disc gradually disappear, and the coloured portions lose their distinctive ruddy tint as they approach the limb." This circumstance appears to prove, however, that a considerable portion of the light from the limb has been reflected before reaching the planet's surface. If Zöllner's supposed mountain-slopes (whose angle he determines at 76°!) existed, we should find brighter colours as well as brighter light near the limb, unless we supposed all the *mountain-tops* coloured and their *declivities* white.

On every hand we receive confirmation of Dr. Schmidt's discovery of the disappearance of the lunar crater Linné. After a careful discussion of the evidence, Schmidt comes to the conclusion that the change which has actually taken place corresponds—only on a greatly magnified scale—to the changes produced by *mud-volcanoes* on our own earth. He conceives that the whole of the internal part of the crater has been filled up by erupted matter, which has further overflowed, so as to obliterate under gently-sloping declivities the once steep outer walls of this vast crater. The matter within the crater seems to have cooled since Schmidt, Secchi, and other observers have detected a minute depression nearly in the middle of the light spot which now marks the place of the crater. If we remember that the crater was described by Lohrman, Beer and Mädler, and others, as "very large" (nearly six miles across) and "very deep," we must recognize the fact that lunar volcanic activity is far from being extinguished.

The eclipse of the sun on March 6th, like most partial eclipses, presented no features deserving of special comment. The occurrence of a severe snow-storm in the upper regions of the air during the progress of the eclipse (accidentally discovered by Mr. Browning while changing the focus of his telescope), is so far noteworthy, as it confirms the opinion expressed by many astronomers, that although the total eclipse of August, 1868, occurs at a season when in certain parts of India traversed by the shadow fine weather is ordinarily expected, yet unfavourable changes may take place in the weather during the actual progress of the eclipse, and through causes corresponding temporarily to those which produce the regular breaking up of the fine season. We trust this anticipation will not be verified, and that astronomers will successfully avail themselves of one of the most favourable opportunities that could ever be afforded of determining the real nature of the red protuberances, and other phenomena visible in a total eclipse.

We have to note an error in our last Chronicle. The deter-

mination of the epoch (850,000 years ago) at which the earth's orbit attained the greatest eccentricity it has had during the past million years is due to the labours of Mr. Croll, who has calculated a table exhibiting the eccentricity, position of perihelion, &c., of the earth's orbit during the above-named interval.

We remind our readers that on the 21st of August, Jupiter will be without visible satellites from 10h. 4m. P.M. to 11h. 49m. P.M. The hours of disappearance and re-appearance of the several satellites were given in our last.

On August 9th, 10th, and 11th, the St. Lawrence meteor-shower may be looked for. Unlike the November star-shower, the August shooting-stars appear almost as frequently *before* as *after* midnight, the radiant-point being above the horizon throughout the night.

On April 3rd, M. Tempel detected a telescopic comet.

Proceedings of the Astronomical Society.

Mr. Tennant has computed the path of the moon's shadow, August, 1868, across the peninsula of India. The central line passes from near Viziadroog, on the western coast, to near Masulipatam on the eastern, the duration of total obscuration being 5m. 12s. at the first place, and 5m. 45s. at the second.

Mr. Brothers succeeded in taking twenty photographs of the sun during the eclipse of March 6th. Mr. Browning's observation of the eclipse is noteworthy on account of the application of a novel method of viewing the sun. A disc of glass having plane and parallel sides was inserted in the open end of a reflecting telescope. The outer side of the disc was coated with a thin film of pure silver, by Liebig's process. This delicate metallic film reflected nearly the whole of the heat, and the greater portion of the light of the sun's rays, its transparency being sufficient, however, to enable enough light to pass through it into the telescope to render very small markings on the sun's surface plainly discernible.

Mr. Stone discusses the possibility of a change in the position of the earth's axis, owing to "frictional action connected with the phenomena of the tides." After a careful examination of two hypotheses, between which the truth in all probability lies, he arrives at the conclusion that the frictional action of the tides "is not available as an explanation of those secular changes of climate which geologists have shown to have taken place on our earth."

Mr. Joynson presents the results of observations of the planet Mars during the late opposition. He considers that there is a permanent dark band extending all round the planet, with only one narrow break in it. But this description is far from presenting the

real complexity of the arrangement of continents and oceans on the southern hemisphere, with which Mr. Phillips's chart and Mr. Dawes's admirable (and consistent) views have familiarized us.

We have an account of a meteor-shower seen at "noon, under a cloudless sky," in Australia, October 25, 1866. One part of the description is not intelligible; we are told that "during (? after) the whole display the sky was filled with a phosphorescence so strong that it gave considerable light to the earth. A river at some distance, which in the clearest moonless nights is invisible from here, glistened quite brightly, even when scarce a star was to be seen through the clouds,"—the hour being noon, and the sky cloudless!

Mr. Masters sends an account of the November meteor-shower as seen at Kishnagur, Bengal. He determined for the radiant-point a position very near that assigned by observers in England. The apex of the Zodiacal light appeared to be some degrees south of the radiant-point.

M. Hoek, in a letter to Mr. De la Rue, discusses the question of solar spots. Taking the mass of a planet and the inverse cube of its distance as the measure of the planet's influence in raising waves of disturbance on the sun, he assigns to Mercury, Venus, the Earth, Mars, Jupiter, and Saturn, effects proportional to the numbers 12, 24, 10, 0, 23, and 7, respectively. This estimate is undoubtedly more correct than that referred to in our last Chronicle.

Sir John Herschel has presented to the Royal Astronomical Society a series of MS. charts, containing the estimated magnitudes of nearly all the stars visible to the naked eye in both hemispheres. The labours of Professor Argelander in the same direction, having been given to the world while Herschel's work was in progress, he was induced to relinquish a task of great labour, and henceforth only of secondary interest. But a large amount of labour having been bestowed on the subject, Sir John considered, and all interested in stellar observation must agree with him, that it would be a pity that the charts should not be preserved.

Mr. Stone has investigated the question of the sun's motion in space by a new and very simple method, founded, however, on views already arrived at on this question. He arrives at the conclusion that there is decisive evidence of the sun's motion, but that the effects of parallactic displacement arising from this motion are on the average much smaller than the independent proper motions of the stars.

Mr. Chambers has compiled a catalogue of temporary stars. Many of the objects included in this catalogue were doubtless comets.

We commend Mr. Dawes's paper on the micrometrical measurements of double stars to the careful study of the telescopic observer.

XUM

Mr. Cleveland Abbe presents a paper on the distribution of Nebulæ. He finds evidence that clusters and planetary nebulæ belong to the Via Lactea, while other nebulæ form independent systems, of which the Nubeculæ are members. It does not appear to have occurred to those who have dealt with this subject, that the marked absence of nebulæ from the zone of the Via Lactea affords as striking evidence of a close relation between the nebular and sidereal systems, as the contrary phenomenon of *aggregation* along that zone would have afforded.

Mr. Kincaid describes an instrument called a *metrochrome*, for detecting changes of star-colours. Such changes have only been certainly noted, as yet, in the case of Sirius and 95 Herculis. They are very difficult to detect, since observers differ greatly in their estimate of colour. Spectrum analysis requires "superlatively fine" weather, and is also for other reasons surrounded by great and numerous difficulties, which render its application almost impracticable. The great difficulty, so far as other methods are concerned, lies in the selection of a standard of reference. A painted scale, like that given by Admiral Smyth, is objectionable on account of the opacity of its colour; and is further not sufficiently reproducible. Precious stones are beyond the reach of most observers. It has been suggested by Mr. Proctor that the illumination of a minute white disc in the focus of a positive eye-piece, "through differently coloured glasses placed on a rotating disc," is a method which might be employed with advantage. Mr. Kincaid prefers the use of chemical solutions (a method suggested by Mr. Huggins). He uses a rotating drum with six equidistant openings, three of which are so constructed as to admit flat-sided stoppered bottles containing differently coloured chemical solutions; the other three openings transmit the normal light of the lantern. By wholly or partially covering one or more of the former openings, and by communicating a rapid rotation to the drum, it will be possible to reproduce the light of a particular star. This light thrown into the telescope produces the image of an artificial star.

4. BOTANY, VEGETABLE MORPHOLOGY, AND PHYSIOLGY.

America.—*Origin of the Canadian Flora.*—Dr. Dawson, of Montreal, has published in the 'Canadian Naturalist' a list of some species of plants he has found in the well-known deposit of Leda-clay at Green's Creek, on the Ottaway, from which he has been able to arrive at a satisfactory estimate of the climate prevailing there at the time of their deposit. Among the species are, *Drosera*

rotundifolia, L., *Potentilla canadensis*, L., *Populus balsamifera*, L., *Potamogeton pusillus*, L., and *Perfoliatus*, L., and others. From the list, it appears that the plants found are a selection of the most hardy species from the present Canadian flora. Dr. Dawson shows that this cannot have been an accidental selection, nor due to the river bringing refuse from more northern latitudes. Hence we must infer refrigeration, and that there *was* such an amount of refrigeration as these plants seem to indicate is borne out further by what would necessarily occur were the land again submerged to the extent that it was at the time of the deposition of the *Leda*-clay. A climate like that of the Labrador coast would be the result.

Australia.—*Culture of Fruit Trees.*—Dr. George Bennett publishes an interesting account, in the 'Journal of Botany' for April, of the extensive orangeries and other fruit-gardens near Paramatta, New South Wales. Oranges, Lemons, Apples, Pears, Loquats, Apricots, Peaches, and superior varieties of Grapes are grown in great profusion, both for export and home consumption, and exhibit a most striking instance of the success attendant on well-directed efforts at acclimatization. The orange, apple, and lemon trees of Mr. Pye, of Paramatta, are grown in a soil consisting of a very poor sandy loam, from which crop out all over the region, large sandstone rocks, the trees being planted around and between them. In the Azores many of the orange gardens are formed in places where there is often not a greater depth of soil than 18 or 20 inches above the shattered volcanic ash. In New South Wales the orange trees frequently give three crops in the year, the fruit of each crop differing considerably in form and size, but all being of excellent flavour. Oranges frequently remain on the tree over fifteen months, and when gathered are in excellent condition. The largest trees grown in this orangery were over 35 feet in height and about the same diameter, such a size being very remarkable. In an orangery in which there were about 70 trees to the acre, Dr. Bennett states that ten on the average yielded 550 dozen oranges in one year. The wholesale price at which they are sold is from 7*d.* to 8*d.* a dozen, anything over 2*d.* per dozen remunerating the grower. The greater number are exported to Tasmania, Melbourne, and New Zealand. Dr. Bennett also expresses his belief that the thin-skinned pipless oranges which are sometimes called the "St. Michael's oranges," are only the result of age and careful cultivation of the tree which produces them; it appears that they cannot be got from seedlings or young cuttings. Wax models of some of the fruit and photographs of the trees in these Australian orangeries have been sent to the Paris Exhibition, where it is believed they will compare very favourably with those of the Northern Hemisphere.

Edible and Poisonous Plants of the order Apocynaceæ.—Dr.

Bennett describes an edible plant, *Alstonia edulis*, found in New Caledonia—the natural order to which the Tanghina Poison-tree of Madagascar belongs—as also the Strychnos, or Nux vomica, and the Oleander; the same order, on the other hand, includes the useful Hya Hya, or Milk-tree, of Demerara (*Tabernæmontana*), the Cream-fruit-tree of Sierra Leone (*Roupellia*), and many others. The *Alstonia edulis* is a climbing plant, the fruit-pods of which are much used in New Caledonia both by natives and Europeans as an esculent vegetable. Another species of *Alstonia*, which is of considerable use dietetically, is the *A. constricta*. It is the Bitter Bark-tree of the colonists, and was supposed at one time to have the properties of Quinine. It really, however, more closely resembles Quassia, and is used as a tonic and for preparing "bitters." Dr. Bennett directs attention to the desirability of cultivating both these plants with a view to their economic applications. Mr. J. F. Wilcox has sent samples of the bark, wood, and decoction of *Alstonia constricta* to the Paris Exhibition.

England.—*The Colouring Matters of Plants.*—Though this is hardly the place in which to notice the optical arrangements and working of Mr. Sorby's spectroscope, we may draw attention to some of the results which he has obtained from its use in investigating vegetable colours. At a late meeting of the Royal Society, he described a new method for registering, by means of an interference spectrum, the position and character of the absorption bands obtained in a spectrum by the interposition of a coloured solution between the spectroscope and source of light. He has also made use of the action of sulphite of soda, citric acid, ammonia, and other reagents for separating or modifying these solutions, and has been able to distinguish above 100 distinct colouring matters. The blue of one flower is not the blue of another, nor are all pinks, greens, and yellows of the same component parts. Two or even more separable colouring matters unite in many cases to give a petal its particular tint and often one of these is peculiar to the plant. The most remarkable fact which Mr. Sorby appears to have elicited is that (in all probability) the absorption bands of any single colouring matter occur at equal distances in the spectrum (allowing for dispersion) and hence that we may infer the presence of more than one colouring matter in a solution which gives absorption bands disposed at unequal intervals.

Alleged New British Heath.—Dr. Hance writes in the 'Journal of Botany' for June, that fifteen years since he gathered in South Devon, near Newton Abbot, an *Erica*, which at the time he considered to be *E. mediterranea*, the rare species which grows in Ireland. He now, however, considers the species to be *E. carnea*. This last species is found in Switzerland, Austria, Germany, Italy, Dalmatia, Hungary, and Greece—not in France—whilst *E. medi-*

terranea is met with in Ireland, France, Spain, and Portugal. Whether the species be the Irish or Swiss species, its occurrence in Devonshire is sufficiently remarkable, and should cause careful search in the locality, which Dr. Hance expressly states was quite wild and distant from cultivated land. At the same time very great importance cannot be attached to an identification resting on a solitary specimen gathered so long since, and which may have occurred under circumstances which would explain the matter, but which have now escaped Dr. Hance's recollection.

Double-flowered Ranunculus.—Dr. Maxwell Masters describes a case of double-flower in *Ranunculus ficaria*, the chief interest of which resides in the structure of the carpels and ovules. The carpels were open, and the ovules sprang from the inner surfaces of these carpellary leaves like little buds. The occurrence of two ovules instead of one, in these monstrous fruits, is noteworthy, as also the fact of their originating neither from the margins of the carpellary leaf, nor from a prolonged axis, but from its inner surface. The rarity with which perfect seeds of *Ranunculus ficaria* are formed is to be attributed to the deficiency of pollen in the anthers of these flowers. *Ranunculus auricomus* is frequently sterile, and other plants of the order exhibit a frequent tendency to the unisexual form. *R. bulbosus* has not been recorded with unisexual flowers, but Dr. Masters recently met with a luxuriant specimen of this species in which every flower was fertilized, although there were no perfect stamens in the flowers.

Babington's Manual of Botany.—A sixth edition of this work, so highly valued by every English critical botanist, has just been published. Fifteen plants are admitted into the manual as genuine additions to the British Flora, while five species are recognized as certainly naturalized foreign species. Nearly all of these species have been recorded, and some of them figured, as they were discovered in Dr. Seeman's very excellent journal of Botany. It has been remarked that the comforts and duties of a University chair too often divert its occupier from those labours which were the stepping-stones to the honourable position. This assuredly is not the case with Professor Babington, nor do we know of any chair at either of the English Universities of which so unpleasant an assertion could be maintained with truth.

New Lichens from Cader Idris.—The Reverend W. A. Leighton, in the June number of the 'Annals,' describes a lichenological tour in the neighbourhood of Dolgelly. Cader Idris appears to be a wonderfully productive locality in the way of lichens and mosses, the only disadvantage it presents to the collector being that which befel Mr. Leighton—that of losing the path on the mountain in misty weather while absorbed in the search for specimens. By his excursion Mr. Leighton has added to our British

Flora a score of new lichens, of which six are entirely new to lichenology, and also a new species of *Sphæria*—thus proving that our Welsh mountains, if thoroughly searched, would yield an abundant harvest of good, rare, and novel lichens, and probably many novelties in other natural orders. Dr. Fraser, who accompanied Mr. Leighton, adds a list of more than fifty species of mosses, which he found near Dolgelly, chiefly on Cader Idris.

Protophyta.—While botanists generally and students of Diatomaceæ especially must feel the loss of so ardent an observer as the late Dr. Greville, it is gratifying to find that others are coming forward in his especial field of research. In the last number of the 'Microscopical Journal,' Dr. Lauder Lindsay describes some new species of Diatomaceæ and Desmidiaceæ from New Zealand, and makes some valuable remarks upon the distribution of the Protophyta, and their representatives in New Zealand. The Rev. Eugene O'Meara, in the same journal, describes eleven new and several rare forms of Diatomaceæ which were dredged on the west coast of Ireland, by Dr. E. Perceval Wright, of Dublin. The gathering is chiefly interesting on account of the number and rarity of the known species and the large percentage of new species.

France.—*Spontaneous Movements in* Colocasia.—M. Lecoq communicates to the 'Comptes Rendus' a notice of some extraordinary vibrations which he has observed to occur regularly in the leaves of the *Colocasia esculenta.* The movements were sufficiently violent to set small bells ringing which were attached to the plant, and thus indicated to M. Lecoq the time of the phenomenon. The vibrations were from 100 to 120 a minute. The plant was kept in a hothouse, and was quite free from draughts or currents of air, which could produce the agitations observed. M. C. Musset published some observations on this plant some time since; he did not observe the movements of the leaves, but noted that during præfoliation the sap was projected from the leaves to a distance of several centimetres through two orifices, in the form of stomata, situated at the apex of the leaf. Eighty-five drops were projected in the minute. The most probable explanation of the *movements* offered by M. Lecoq is that in his plant, for some reason or other, since he did not observe any projection of sap, the terminal orifices were inactive, and that the projecting force was thus converted into a vibrating force.

Germany.—*The Function of Chlorophyll in the Chemistry of Plant Life.*—Dr. Ferdinand Cohn, of Breslau, in a paper "On the *Phycochromaceæ* and *Floridеæ*," in the January number of the 'Archiv für Mikroskopische Anatomie,' describes at some length the colouring matters of various low forms of Algæ. He shows that the colouring matter in all—red, blue, green, yellow, or brown—contains Chlorophyll, or a closely allied body, and main-

tains that Chlorophyll (or some closely-allied modification thereof) is contained in all growing plants, as the principal actor in the process of assimilation, acting perhaps in a manner analogous to that which the oxygen-carrying constituents of blood exhibit in animals. Dr. Cohn has also recently shown elsewhere that the presence or absence of Chlorophyll in the lowest forms of Plants and Animals has a very important bearing on their direction of motion. They always move towards the light, and if variously coloured light be used, towards the highly refractive actinic rays in preference to the thermal red ones.

Dr. Cohn believes that the decomposition of carbonic acid and the evolution of oxygen through the Chlorophyll, under the influence of light, offer a fair explanation of some of the movements of these minute coloured organisms.

A fragment of chalk coated over one half with a resinous cement and placed in dilute acid is projected with the coated surface foremost, by the evolution of carbonic acid from the exposed extremity. In a similar manner, Dr. Cohn supposes that the chemical action induced by the action of light on the chlorophyll aggregated at one part of such bodies, as the *Oscillariæ* or *Euglenæ* may give rise to those axial rotations which frequently become apparent as longitudinal motion. Dr. Cohn also mentions certain *Oscillariæ*, namely, the genus *Beggiatoa*, which, probably by the decomposition of sulphates, develop free hydrogen-sulphide in the water in which they thrive. Since this group of algæ alone can flourish in hot and strongly saline solutions, he suggests that it is probable that the first organisms which were present in the primordial sea which covered the earth, and was of very high temperature, if we may reason upon the inductions of geologists, were *Oscillariæ* or rather *Chroococcaceæ*.

The Situation of the Alkaloids in the Bark of the Cinchonæ.—Any facts relating to the sources or supply of Quinine must have considerable interest. Some years since M. Wigand tried to demonstrate that the alkaloids of the Cinchonas are developed in the liber. He observed that thin sections of the bark soaked in cochineal became stained more strongly in that layer which is known as liber, than in that part of the bark called parenchyma; and from this he concluded that quinine was more abundantly present in the liber than in the parenchyma, acting as a mordant. M. Carl Müller, having failed to confirm M. Wigand's observations, has adopted a different method of examination. He by a very ingenious process separates the liber and parenchyma, and then analyses the two separately. He finds that the parenchyma contains 9·876 per cent. of quinine, whilst the liber only contains 2·462 per cent. It appears also that the quinine is the more abundant in proportion as the bark is more developed, which would lead one to

suppose that the production of quinine is in relation with the formation of the liber. This consideration has naturally led M. Müller to inquire at what period and in what region of the bark the first appearance of the quinine takes place, and he proposes to take up this question as soon as he can procure a sufficient number of living Cinchona-plants.

Fungi-spores.—Professor Karsten has published some observations on the stylospores of *Sphœriæ*. *Sphœriæ* were found in the opened anthers of *Fuschia splendens*, which when placed in water, gave exit to a white tortuous thread, which quickly broke up in the water, into innumerable simple oval vesicles. These vesicles when moistened with dilute solution of iodine acquired, like starch, a beautiful violet colour, and when preserved in glycerine, disappeared in a little time. This is probably the first known example of a starch-reaction in the spores of Fungi, as which (and indeed, as stylospores) the corpuscles noted must be regarded, and although a similar reaction of the spores was observed by Currey in the Lichens, and in the plant named *Amylospora tremelloides* by that botanist, it is nevertheless worthy of notice as certainly a very rare occurrence among these plants.

5. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

In recording recent discoveries and progress in Chemistry, we may in the first place mention two facts which have, however, as much relation to physics as chemistry. The first is a new determination of the density of ozone, by M. Soret. We have already recorded* the conclusion to which M. Soret was led by his former experiments, *viz.* that the density of ozone was one-and-a-half times that of oxygen, or 1·658. This conclusion he has recently confirmed, by determining the rate of diffusion of ozonized oxygen, which was found to correspond exactly with the rate required by Graham's well-known law.

We have in several numbers referred to the invaluable labours of M. Berthelot on the Hydrocarbons, and not long since† to his important paper on the action of heat on these bodies. His more recent experiments have been devoted to the oxidation of hydrocarbons, and have yielded interesting results. Acetylene, $C_4 H_2$, only differs from oxalic acid by wanting eight atoms of oxygen. M. Berthelot finds that these can be added directly; and thus, seeing that he has already formed acetylene by the direct union of its

* Vol. iii., p. 264. † Page 78.

elements, we have oxalic acid built up by the successive combination of its constituent elements. In order to produce oxalic acid in this way, gaseous acetylene is shaken up with a strongly alkaline solution of permanganate of potash, added gradually as long as the solution is decolorized, and taking care to keep the flask cool. When the operation is ended, the solution is filtered from the binoxide of manganese. The oxalic acid will be found in combination with the potash, and may be separated by means known to every chemist. Formic and carbonic acids are produced at the same time as oxalic acid, no doubt, M. Berthelot states, by the splitting up of some nascent oxalic acid.

Several other hydrocarbons were experimented with in the same way. Ethylene gave the same products as acetylene. Allylene gave malonic, acetic, and carbonic acids. Amylene gave oxalic, and a mixture of several others, probably pyrotartaric, succinic, and malonic acids. Styrolene yielded benzoic and carbonic acids.

M. Berthelot has also succeeded in forming toluol synthetically. The formula of toluol, $C_{14}H_8$, indicates the addition of marsh gas to benzol with the elimination of two atoms of hydrogen.

$$\underbrace{C_{14}H_8}_{\text{Toluol.}} = \underbrace{C_2H_4}_{\text{Marsh Gas.}} + \underbrace{C_{12}H_6}_{\text{Benzol.}} - 2\,H.$$

The excessive heat required to effect the direct combination of these bodies was fatal to the existence of toluol, and a product of its condensation, anthracene, was obtained. By bringing them together in the nascent state, however, the desired combination was effected, and toluene formed. This was done by submitting a mixture of acetate and benzoate of soda and lime to distillation. Besides toluol some other hydrocarbons were produced, which M. Berthelot regards as higher homologues of toluol.

An important paper "On new Hydrocarbons obtained synthetically" has been published by Fittig & Bigot. For this we must refer the reader to the original, or the translation indicated below.*

The researches of Mr. P. Griess "On a new Series of Organic Compounds, in which Hydrogen is replaced by Nitrogen," have led him to the discovery of a highly explosive series of salts, one of which he proposes as a substitute for fulminating mercury. This is the chromate or chlorochromate of diazobenzol. According to the French patent, it is prepared in the following way:—One equivalent of hydrochlorate of aniline is mixed with two equivalents of hydrochloric acid, and to these one equivalent of nitrite of soda in strong solution is very gradually added. The mixture is left to itself so long as any nitrogen is disengaged. In this way diazobenzol is produced. To precipitate the salt named above, a concentrated solution of one equivalent of bichromate of potash in one

* 'Ann. der Chem. u. Pharm.' Bd. cxli., p. 160. 'The Laboratory,' vol. i., p. 121.

equivalent of hydrochloric acid is added. It is unnecessary to say that the precipitate must be collected and dried with the greatest precaution, since its explosive force is said to surpass that of fulminating mercury.

While on the subject of explosive compounds we notice Mr. Abel's paper on the "Stability of Gun Cotton," read at the meeting of the Royal Society on April 4.* One objection brought against the use of gun cotton is its liability to spontaneous changes, sometimes resulting in explosion, and in other cases rendering the cotton useless. This, as was stated by Mr. Crookes in an article in our first volume,† is simply the result of imperfect manufacture; an opinion which the experiments of Mr. Abel confirm. Tri-nitrocellulose, or perfect gun cotton, is not liable to any spontaneous change; "but the best manufactured article may contain some organic nitrogenized impurities of comparatively unstable properties, which have been formed by the action of nitric acid upon foreign matters retained by the cotton fibre, and which are not completely removed by the process of purification"—that is boiling the raw cotton in a solution of caustic alkali. It is these impurities—not usually amounting to more than two per cent.—which are prone to change when gun cotton is stored in the dry state.

The first result of the change is the production of a little free acid, and if the change be allowed to proceed it goes on to the complete destruction of the cellulose products. But the experiments of Mr. Abel show that the change may be arrested at the primary stage, and the stability of the material ensured for ever. This result is obtained at once by uniformly distributing through the cotton a solution of carbonate of soda. One per cent. of carbonate of soda, Mr. Abel has found, will afford to the material the power of resisting any serious change, even when exposed to such temperatures as would cause the decomposition of pure and perfect gun cotton without this protection.

Water perfectly protects gun cotton from alteration. Actual immersion is not necessary; if only damp to the touch it undergoes not the slightest change, and may be closely packed in large quantities without risk. The safety from explosion Mr. Abel courageously illustrated by taking two or three pounds of damp cotton in his hand, and plunging a red-hot poker into it. Thus gun cotton damped with a proper amount of carbonate of soda solution may be transported without risk to any part of the world, and may then be easily dried for use; and it is a curious fact that while raw cotton requires a temperature of not less than 240° F. to drive off all moisture, gun-cotton becomes perfectly dry at about 180° F.—the heat required to explode being 300°.

* 'Proceedings of Royal Society,' vol. xv., p. 417.

† 'Quarterly Journal of Science,' vol. i., p. 407.

Gun cotton is however hygroscopic, and on this account has been found uncertain when made into cartridges. A sportsman, for example, would make good shooting in the early part of a damp day, bad in the middle, and worse in the afternoon. This objection to the use of gun cotton, so much to be recommended on other accounts for sporting purposes, has been obviated by the Messrs. Prentice, who now enclose each charge in the thinnest possible coating of india-rubber, by which the access of moisture is completely prevented.

Of two other important papers communicated to the Royal Society we can only give the titles. The first is by Mr. H. C. Sorby, "On a Definite Method of Qualitative Analysis of Animal and Vegetable Colouring Matters by means of the Spectrum Microscope."* This is really a continuation of the experiments described in an article in our own pages,† made with improved apparatus and a more definite aim. The paper requires very careful reading at length for the full understanding of its contents. While on this subject we may refer the reader interested in the matter to a valuable paper by M. Preyer, "On the Quantitative Determination of Colouring Matters of the Blood by means of the Spectroscope."‡

The next is a paper by Sir B. Brodie, read May 3rd, and entitled "The Calculus of Chemical Operations: being a Method for the Investigation, by means of Symbols, of the Laws of the Distribution of Weight in Chemical Change." For this, which will be a sealed book to all but chemists familiar with the higher branches of algebra, we must refer the reader to the original paper in the 'Philosophical Transactions,' or a useful abstract in the 'Chemical News' for May 31st.

A few processes of technical interest have been brought to notice within the past quarter. Among these is one by Stolba, for easily obtaining Sulphurous Acid on a large scale. When sulphate of iron or sulphate of copper is heated with sulphur, sulphurous acid is given off, and the sulphate is reduced to sulphide:—

$$FeO, SO_3 + 2\,S = FeS + 2\,SO_2.$$

To carry out this process practically, two-and-a-half parts of dry sulphate of iron are mixed with one part of sulphur, and heated in an iron retort, provided with a tolerably wide exit tube. This process perhaps may be made available in some manufactures.

A great advance has been made in the manufacture of aniline dyes by MM. Girard and De Laire, who have succeeded in extracting three new dyes from the residues of the manufacture of rosaniline, in which one half the aniline employed has hitherto been

* 'Proceedings of Royal Society,' vol. xv., p. 433.
† Vol. ii., p. 98.
‡ 'Annalen der Chemie u. Pharm.' Bd. 140, p. 187.

wasted. They name the bases of these colours Mauvaniline, Violaniline, and Chrysotoluidine. The methods by which these are separated are described in the place indicated below.* The manufacture has been patented in France, and probably also in England.

A new blue has also been patented in France, by the same gentlemen. It is made by heating, under pressure, a mixture of commercial aniline (aniline and toluidine) and hydrochlorate of the same aniline with terchloride of carbon. The result is a bronze-coloured mass, which is purified by first treating it with benzol or petroleum, which will leave the dye undissolved; then dissolving in wood-spirit or alcohol, and finally precipitating with hydrochloric acid.

In connection with Technical Chemistry, we may mention a paper of interest "On the Waste of Materials in the Alkali Manufacture," † by Mr. James Hargreaves.

In this and the one mentioned subsequently in our report of the proceedings of the Chemical Society, the alkali manufacturer will find valuable information.

A fact of much interest to the chemist and geologist observed by M. Daubrée deserves a passing notice. Felspar reduced to the finest powder does not give the faintest alkalinity to water. But M. Daubrée finds that fragments of felspar violently agitated with water will give up to the water as much as two per cent. of the potash it may contain. The author sees in this an easy means of obtaining an alkaline water for washing linen; but at the same time remarks that it may throw some light on the changes which are taking place on the surface of our earth.

Some important contributions to analytical chemistry have also been made. A noteworthy paper, "On Pugh's Method of Determining Nitric Acid," has been published‡ by MM. Chapman and Schenck.

This method, which has specially recommended for the determination of nitric acid in water, has been found by the authors to be altogether faulty under the conditions in which it is likely to be employed. The method will be well known to all our chemical readers, and therefore we need only say, that in the presence of nitrogenized organic matter, the authors have found it to be simply valueless, inasmuch as such bodies as albumen, gelatine, and urea, all yield ammonia when digested with protochloride of tin.

Some analytical notes on Cadmium, by Wohler,§ give methods of separating this metal from zinc and from copper. To separate cadmium and zinc, the author adds a large excess of tartaric acid,

* 'Bulletin de la Société Chimique de Paris,' May, 1866.
† 'Chemical News', vol. xv., pp. 219–232.
‡ 'The Laboratory,' No. 9, p. 152.
§ 'Chemical News,' vol. xv., p. 166.

then renders the solution strongly alkaline with caustic soda, and boils for several hours. Cadmium only is deposited.

To separate the sulphides of cadmium and copper, the author dissolves in hydrochloric acid and adds chlorate of potash. The solution may then be treated as above, and the copper recovered from the filtrate, by first oxidizing aqua regia, and then precipitating with caustic potash.

Dr. R. Wagner gives * a "Hydrostatic test for the detection of Paraffin in Bees' Wax." The specific gravity of pure bees' wax, he finds to be from 0·965 to 0·969; and of commercial paraffin from 0·869 to 0·877. Mixtures of the two will of course give intermediate gravities; and in the author's experiments the results closely agreed with those required by calculation. Pure bees' wax, it is added, should sink in spirit of wine, sp. gr. 0·961: if the wax should float, the presence of paraffin may be suspected.

The same author gives a ready means of detecting stearic acid in paraffin. An alcoholic solution of neutral acetate of lead gives no precipitate in a boiling alcoholic solution of paraffin; but if stearine is present, a turbidity or flocculent precipitate is produced.

Dr. Wagner also shows that the density of a specimen may afford some information on the probability of the adulteration of oil of bitter almonds with nitrobenzol. The former has the sp. gr. 1·040–1·044, the density of ordinary nitrobenzol varies from 1·180 to 1·201. A better test, however, is a strong solution of bisulphite of soda, with which genuine oil of bitter almonds forms a crystalline mass. On carefully adding a little water, the nitrobenzol will float on the surface.†

Proceedings of the Chemical Society.

At the meeting on March 7th, Mr. E. T. Chapman read a paper "On the Oxidation of Formic Acids." This acid, unlike those of the acetic and aromatic series, the author has found does not resist the oxidizing action of a solution of chromic acid, which converts it into water and carbonic acid.

Dr. Dupré afterwards read a "Note on the Synthesis of Formic and Hyposulphurous Acid." Formic acid is produced by the action of sodium on carbonic acid. Reasoning from analogy, the author supposed that hyposulphurous acid would be formed by the action of sodium on sulphurous acid, a prevision which experiment confirmed. Dr. Dupré is thus led to regard hyposulphurous acid as

* 'Zeitschrift für. Analyt. Chem.,' 1866, p. 279.
† Ibid., p. 285.

the formic acid of the sulphur series, and suggests that the atomic expression may be simplified by halving the common formula thus:—

$$Na_2H_2S_2O_4 = 2\ (Na\ H\ SO_2).$$

An interesting conversation followed the reading of these two papers, in the course of which Dr. C. Calvert mentioned that in making formic acid by the oxalic acid and glycerine process, he had observed that the acid was produced slowly at first, but that on adding a fresh quantity of monohydrated oxalic acid, the action went on very regularly. Dr. Odling suggested that this might be explained by the supposition that a formiate of glycerine was first formed, and subsequently decomposed. Mr. Chapman thought that an oxalate of glycerine was first produced, which, under the influence of heat, split up into formic and carbonic acids, the glycerine being regenerated. Referring to Dr. Dupré's paper, Mr. Chapman added that he could not allow that sulphur played the part of carbon, or that there was any analogy between formic and hyposulphurous acids.

Dr. F. C. Calvert then gave a short account of some experiments, in the course of which he had found that a large proportion of the mineral phosphates in cereals, peas, beans, and also cotton, could be extracted by digestion in water.* Such solutions always contain much magnesia.

Mr. Spiller reminded the audience of an experiment of Dr. Hofmann, who used to show that the addition of ammonia to infusion of malt or pale ale always produced a precipitate of ammonio-magnesian phosphate.

Dr. Calvert then described some results obtained by the action of charcoal impregnated with oxygen, a longer account of which was given at a subsequent meeting.

On March 21st, Dr. Gladstone read a paper "On Phosphonitril," PNO, a white solid, produced by heating the product of the action of ammoniacal gas on the oxychloride of phosphorus, and which has been described before under the names "*phosphamide*" and "*biphosphamide*,"—names obviously inapplicable since the body contains no hydrogen. Dr. Gladstone therefore proposes the new name, *phosphonitril*, a designation which met with the approval of Mr. T. Sterry Hunt, who had fifteen years ago described it as the nitril of phosphoric acid.

Mr. J. Parkinson then read a paper "On Phosphide of Magnesium," Mg_3P, formed by heating magnesium with phosphorus in an atmosphere of hydrogen. Phosphide of magnesium rapidly decomposes water, forming phosphide of hydrogen and oxide of magnesium.

* It has long been known that the washings of starch manufacture contained a large quantity of phosphates, and they have consequently been recommended for manure.

At the same meeting, Dr. Squire exhibited a specimen of "frozen glycerine," imported from Germany, which attracted much attention, glycerine being reputedly non-congealable. It was said that no sugar or other crystallizable matter could be detected in the specimen.*

The annual meeting of the Society was held on March 30th. We need only mention that the Report showed the increasing prosperity of the Society, and contained a notice that the Council had under their consideration a proposal for raising the standard of qualification for the Fellowship.

On April 4th, Dr. Calvert's paper "On Oxidation by means of Charcoal" was read. The author experimented with freshly burnt charcoal saturated with oxygen. Such charcoal quickly changed sulphurous into sulphuric acid, and sulphide of hydrogen into water and sulphuric acid. The vapour of common alcohol diffused in oxygen was converted into acetic acid, and anylic alcohol similarly into valerianic acid. Many other bodies were experimented with, but the results obtained are not yet accurately made out. Dr. Calvert speculates that the condensation of oxygen and other gases within the pores of the charcoal amounts to actual liquefaction.

The President referred to the condition of some solid bodies—metals, for example, under great pressure, when they seemed to behave like liquids, a subject which has lately received further illustration at the hands of M. Tresca.

On April 18th, Mr. J. Spiller read a paper, entitled "Observations on the Weathering of Copper Ores." The paper referred to the action of air and water on some Devonshire ores containing mundic, spathic iron ore, mica-schist, and copper pyrites. The experimental observations showed that not only sulphate of copper is produced by the action of air and moisture, but that secondary reactions occur in the presence of spathic iron, aluminous schist, and other minerals, the metallic bases of which are converted into sulphates at the expense of an oxidized portion of the sulphur in the original ore. Mr. Spiller obtained some of his results by an examination of the water of a stream in which the ore referred to was washed; and he points out the advisability of adding lime or chalk to such water to avert the ill-effects of water so impregnated with mineral poison on the meadows irrigated by it.

Professor A. H. Church, who had visited the locality, referred to the poisonous effects of the sulphates of copper, iron, and manganese on vegetation, and mentioned that while the stream above the workings was full of water-weeds, they, as well as fish, disappeared immediately below.

At the same meeting, a paper by Messrs. E. T. Chapman and

* Mr. John Williams has since found a considerable amount of sulphate of soda in a portion of the quantity imported.

M. H. Smith, "On the Oxidation of Acids of the Lactic Series," was read; and also a note by the same authors, "On Limited Oxidation by Alkaline Permanganate." In this latter paper the authors pointed out the differences in the products of the oxidation of common alcohol by acid, and by alkaline permanganate. In the former case, acetic acid and aldehyde are produced, while in the latter nothing but oxalic acid is obtained. Lactic acid gave similar results. The authors pointed out a means of distinguishing between citric and tartaric acid by the use of a strongly alkaline solution of permanganate. Citric acid only carries the reduction to green manganate, while with tartaric the reduction to brown hydrated binoxide is complete.

A paper, by Dr. F. C. Calvert, "On the Presence of Soluble Phosphates in Cotton Fibre, Seeds, &c.," was afterwards read. The author's experiments have led him to the conclusion that the whole of the phosphoric acid or phosphates is merely held mechanically distributed through the organic tissue, and may be wholly extracted by the action of water. He showed that cotton yarn steeped in water yielded a solution containing phosphoric acid, lime, and magnesia. Wheat, French beans, and walnuts gave similar results.

The meeting on May 2 was occupied with a discussion, originated by Dr. Odling, on the use and misuse of the term "atomicity." The discussion was continued by Professors Williamson and Miller, who advocated the substitution of the term "equivalence," and by Dr. Thudicum, who has proposed the word "dynamicity." For a full report of this interesting discussion we must refer our readers to the Chemical Journals.*

The last meeting we can notice was held on May 16. At this Mr. W. H. Perkins, F.R.S., made an interesting communication on the artificial formation of Coumarine. This substance, which was discovered by Delalande in the Tonquin Bean, has the formula $C_9H_6O_2$. When gently heated with a solution of caustic potash it assimilates water, and becomes coumaric acid, $C_9H_8O_3$; but when fused with hydrate of potash it splits up into salicylic and acetic acids. Mr. Perkins has found that by acting on the sodium compound of hydride of salicyle with acetic anhydride, he obtains a product completely identical with coumarine. The full details of the experiment the author reserves for a future communication.

The Secretary then read a paper by Professor Rammelsberg, "On the Constitution of the Phosphites."

The next paper was by Dr. Dupré, "On the Changes in the Proportion of Acid and Sugar in Grapes during the progress of Ripening." The author's experiments go to show that the amount of acid varies but little during the progress of ripening, while, of

* 'Chemical News,' May 10, 1867.

course, the proportion of sugar greatly increases. His inference is that the acid is not converted into sugar; although it may assist in the production.

The next paper, "On the effects produced by the addition of Plaster of Paris to Must," was also read by Dr. Dupré. Wherever wine is made, the makers have the habit of adding plaster of Paris to the grape-juice either before or during the progress of fermentation. The author showed that the effect of this was to remove some of the tartaric, leaving the malic acid, and to introduce into the wine sulphates of potash and lime. He believes wine to be greatly deteriorated by the addition.

A description of "An Adapter to be used in connection with a Sulphuretted Hydrogen Apparatus," contrived by the Rev. B. W. Gibsone, was then given by the secretary. For this we must refer our readers to the Chemical Journals.

A valuable paper, "On the Practical Loss of Soda in the Alkali Manufacture," by Mr. C. R. Wright, was then read. The total loss in the process of converting common salt into refined ash is estimated by the author at 24 per cent. Mr. Wright has determined the amount of loss at different stages of the process, and his communication, when published at length, will afford valuable information to all manufacturers of soda.

6. ENGINEERING—CIVIL AND MECHANICAL.

The recent depression in engineering enterprise, consequent on the financial crisis of last year, has not yet recovered so far as to give any impetus to the prosecution of new undertakings. It is true that most descriptions of security have experienced a considerable rise in marketable value, but the public mind has evidently not yet sufficiently recovered from the shock it had received to enable it to look favourably on fresh enterprises as a means for investment, and consequently but few new works of any magnitude have at present any chance of finding supporters in the public money-market. At the same time, the cheapness of money and the abundance of floating capital seeking investment have been sufficient to provide for the completion of many works previously in course of construction. But this has not invariably been the case. The works of the Waterloo and Whitehall, and of the Metropolitan District Railways, are at present at a standstill, and doubtless many other promising undertakings are similarly languishing for want of funds.

Amongst the lines of railway recently completed may be mentioned the Chemin de Fer du Ceinture at Paris, which was opened for passenger traffic throughout on Monday, the 25th February

last. This line is 22 miles in extent, and almost completely encircles Paris within the fortifications. The Calais and Boulogne Railway was opened for passenger traffic on the 1st April, and by it half-an-hour is saved in the journey between Paris and London. The Charente Railway Company has opened a section from Rochefort to Saintes, and the Northern of France Company has opened a line 73 miles in length from Amiens to Rouen. At the commencement of the present year, the length of railway open in Spain was 3,182½ miles; the distance in course of construction was 356⅞ miles, and 512½ miles remained still to be commenced out of the lines conceded. The total extent of railways in Italy at the close of last year was 2,572 miles, 404 miles having been opened in the course of 1866. A line from Civita Vecchia to Nanziatella, which is to unite the Leghorn line to Rome viâ the Marennes, is now ready for traffic. Among the works especially deserving of notice on this line, are bridges over the Mignone, the Marta, the Arone, and the Fiera. By the transfer of Venetia to the kingdom of Italy, the network of Italian railways has been increased to the extent of 600 miles. An uninterrupted line of railway has now been established on the eastern side of the Italian Peninsula. The opening of the line from Ancona to Foligno and Rome, puts the North in communication with Naples, and Florence has now also uninterrupted railway communication with Rome. In Russia, surveys for great lines uniting the Baltic to the Black Sea and the Caspian Sea are expected to be pushed forward; several applications have recently been addressed to the Russian Government for new lines, either from foreign or domestic capitalists. At the close of last year 885⅝ miles of railway were decreed in Holland, of which 616⅞ miles were in operation, while 193¾ miles were in course of construction, leaving 75 miles still to be constructed. In the course of 1866, about 110 miles of line were opened for traffic. In India there has recently been opened a further section of the line between Bombay and Calcutta, leaving only 200 miles yet to be completed in order to unite those two capitals. A section of railway between Delhi and Meerut was opened on the 15th of April; and a branch railway between Lucknow and Cawnpore was opened on the 23rd of April last. Trains have also within the last month commenced running on the Ceylon Railway.

A new bridge has recently been completed on the Rhine between Manheim and Ludgwigshafen, consisting of three openings of 290 feet span each, and a project has been brought forward for the construction of another great bridge over the same river, near Dusseldorf.

The Hoosac tunnel, the largest work of the kind yet attempted in America will be about 4½ miles in length, and its sectional area 459 square feet. Only 4,600 feet, of about half the full section,

has yet been penetrated at both ends; the central shaft is to be 1,030 feet deep; the tunnel itself is elliptical in section, 27 feet by 15 feet, and is now down 400 feet.

The quay walls of the new Windmillcroft Dock on the Clyde were completed early in March last; this dock is 1,050 feet long by 250 feet broad, and has an area of rather more than 5 acres. The Norfolk Estuary Company have very recently completed another embankment of two miles in length at North Wooton, by means of which 700 acres has been added to that already reclaimed in the Wash, and makes a total of about 4,000 acres of the 32,000 to be recovered from the sea by that Company. We are informed that, after extensive soundings, Mr. Hawkshaw has abandoned his project for a submarine channel railway between England and France; and from a contemporary journal we observe that it is intended to make a subaqueous tubular bridge across the bed of the Mississippi at St. Louis, at which point the river is about half-a-mile broad.

A great deal of progress is just now being made in the construction of telegraph lines, especially submarine. The Electric Telegraph Company have laid a second wire to the Isle of Wight; and a fresh cable has been laid between Hull and New Holland. In January last a submarine cable, 29 miles in length, was laid between Ceylon and the main land, being the first yet constructed on Mr. Hooper's principle, which principle has, we observe, obtained a gold medal at the Paris Exhibition. A contract was, not long since, signed with the Telegraph Construction and Maintenance Company for a submarine cable between Placentia, Newfoundland, and Sydney, Nova Scotia; and Messrs. Silver and Co. have recently manufactured a cable, 110 miles in length, for submergence between Florida and Cuba. The works on the Russo-American line have, it is stated, now been abandoned. An iceberg recently grounded within a mile-and-a-half of the Newfoundland coast and cut the new (1866) Atlantic cable, so that the old cable had for some time all the work to do by itself, but the fracture has now been successfully repaired. Before leaving the subject of telegraphy, we may notice that the Government have in preparation a scheme for acquiring a right over the whole of the telegraph lines throughout the United Kingdom, and to work them in connection with the Post Office. A bill for this purpose will be introduced as soon as the Reform Bill has been sent to the Upper House.

The use of steel in locomotive construction is beginning to be more thought of than heretofore. There have been now at work for some years, on the Maryport and Carlisle Railway, several locomotives having steel boilers, fire-boxes, and tubes, as well as steel tyres, piston rods, and motion bars; and there have recently been constructed for the Paris and Sceaux line, and for the Southern Railway of France, several engines with steel boilers. The use of

punched steel gun-barrels is rapidly extending, and the principle introduced by Messrs. Deakin and Johnson is being applied to other purposes connected with machinery. Bessemer steel is now beginning to be used for bridge construction, and it is stated that a recent French invention is likely to be able to compete successfully with the Bessemer process for the manufacture of steel. It may be accepted as a general belief that the age of iron is gradually passing away, and that in most cases where it is now employed, steel will shortly take its place, as being both stronger and lighter.

The use of water-tube boilers may be classed as one of the inventions of the day, their increased strength and security contributing greatly to their popularity. Messrs. Howard, of Bedford, have recently tested their water-tube boilers to a pressure of 1,000 lbs. per square inch.

It is reported that in America very heavy guns are now worked entirely by steam. A centrifugal gun has been invented by Dr. Steinheill, which, it is asserted, will throw from 60 to 100 bullets a minute, but the power necessary to obtain that result is not clearly stated. Major Palliser has been awarded 15,000*l.* for his pointed, or ogival-headed chilled shot, and in consequence of their great power of penetration experiments have lately been made of the manufacture of armour-plates having a steel face welded to an iron body, and of plates formed of alternate layers of iron and steel, with a view to obtaining greater strength without increasing the weight.

7. GEOGRAPHY.

(*Including the Proceedings of the Royal Geographical Society.*)

The subject which of all others has attracted the interest of not only the Royal Geographical Society, but also of all who interest themselves in the annals of enterprise, is the probable fate of Dr. Livingstone. Some time since Dr. Kirk wrote from Zanzibar, giving a graphic and, as it seemed at the time, a probable account of the murder of the enthusiastic traveller by a warlike tribe on the western side of the lake Nyassa. The story was derived originally from certain Johanna men who had been with Dr. Livingstone, but who returned without him. Bit by bit the weak points of the account came out. The tale depended upon the evidence of one man, Moosa, who has proved unworthy of credit, inasmuch as he has since given another version of the same event; a white man is reported to have been travelling amongst more distant tribes, and Dr. Livingstone himself is said to have been

heard of by a caravan of merchants as having passed the spot of his supposed death and as making onwards inland. At the instigation of the Royal Geographical Society, an expedition is to be assisted by the Government, and the men who undertake this work will accomplish something, whether they discover any traces of the former traveller or not. They take with them a steel boat in portable pieces, which will be launched on these mighty lakes, and which will assist in the solution of some of the problems connected with them. The loss of Dr. Livingstone, if he prove to be dead, is undoubtedly a great one, and much to be regretted; at the same time a fictitious excitement has been caused by the publication of unsifted scraps of information which only serve to add conjecture to conjecture.

As to other parts of Africa, M. de Sainl in the centre, and Professor Freilli in the north, are making attempts to penetrate the interior. The detention of the captives in Abyssinia still continues, and Dr. Beke has published a second edition of his work* on that country, with remarks on the late proceedings. Naturally he condemns the diplomacy which has brought such deplorable results, and which was opposed to his advice. An account of Madagascar† by a missionary gives a fairly full description of the people, who seem to be advancing towards civilization at a tolerably rapid rate.

The Russian Government has been giving full employment to its topographical corps in surveying and mapping out their newly-acquired territories in Manchuria and the neighbouring states, so that the whole of the southern border of the empire is now delineated on a scale suited for practical purposes. Whilst Russia is thus advancing upon China from the north, the Government of India is having surveys of much of the country between Burmah and the Celestial Empire, whilst an endeavour is being made to bring the provinces formerly in dependence on China, but now independent, into commercial relations with northern India. Viscount Pollington has traversed some portion of Central Asia, and has written a book,‡ which however does not contribute much to our previous knowledge.

Dr. I. I. Hayes, the Patron's Medalist of the Royal Geographical Society this year, has written an excellent book on his late expedition among the Esquimaux. His opinion, as well as that of M. Gustave Lambert, backs that held already by many German and English geographers, and advocated in former numbers of this journal, that there is open sea towards the North Pole. The last-named gentleman advocates the attempt by Behring's Straits, and

* 'British Captives in Abyssinia,' by Chas. T. Beke, Ph.D. Longmans.
† 'Madagascar Revisited,' by the Rev. H. Ellis. Murray.
‡ 'Half Round the Old World.' Moxon.

urges his own countrymen to carry off the glory of the discovery from other contending nations.

A Peruvian expedition has been exploring the south-western tributaries of the Amazons with some success. Several of these rivers have been found navigable; but the tribes amidst which they flow are cannibal and bellicose. The explorers arrived within 400 miles of the Pacific coast, and it is hoped that it will be possible, by means of a railway, to open up traffic between the two oceans. The fish of this mighty stream and its tributaries have been subjected to the researches of Professor Agassiz. He finds in the main stream as many as 2,000 different species, several of which are highly useful. Of these, nearly 200 kinds—more than the whole Mississippi can produce—were to be obtained within a few yards of one another.

According to an American paper, an attempt has been made—which however was not entirely successful, even if we trust the high-flown language of the traveller who narrates it—to ascend Orizaba, the highest mountain in Mexico, close to one of the last places of retreat of the unfortunate emperor. Very accurate numbers are avoided by the writer, but he professes to have advanced to a greater height than 16,000 feet, when the party was stopped by the general fatigue, and by the fall and injury of their leader. Farther north the great lakes are affording a problem not easy of solution. The huge stream of the St. Lawrence flows from them, but they are fed by only a few insignificant streams. Whence comes all this body of water? Is it from subterranean sources? and if so, where can so vast a drainage be collected?

Mr. E. Whymper, of the Alpine Club, is going to Greenland to try whether his experience in Switzerland will enable him to make some ascents of mountains which will give more scientific results than those commonly undertaken by members of the club.

In Europe but little has taken place of geographical interest, except that the volcanic system of the Mediterranean has been for some little time in a state of considerable activity, giving indications of changes in the earth's surface. A good account of the Sclavonic provinces of Turkey is given by Messrs. G. Muir Mackenzie and A. P. Irby* in a heavy but useful book.

In anticipation of the medals of our own Society being given to foreigners, the Geographical Society of Paris has presented Sir Samuel Baker with its gold medal for the current year. The Academy of Sciences has elected M. d'Abbadie to the chair of Geography after a close contest. A sum of 4,000 francs has been laid aside by Mme. Guévineau, sister of the traveller Lalande, to be presented to the traveller who shall have been most instrumental in improving human food.

* 'The Turks, Greeks, and Slavons.' Bell & Daldy.

We would call attention to the following works on Geography lately published:—'Géographie de Strabon,' traduction nouvelle par Amédée Tardieu. Duarte Barbosa's 'Description of the Coasts of East Africa and Malabar in 16th Century,' translated by the Hon. H. E. J. Stanley. A kind of geographical novel, called 'Wild Life among the Pacific Islanders,' by E. H. Lamont. The three following German works,—'The Prussian Expedition to Eastern Asia, from Official Sources,' a good account of Japan, &c.; L. Hacker's 'American Sketches;' Dr. H. A. Pagenstecher's 'Sketches of the Balearic Islands;' Shepherd's 'North-west Peninsula of Iceland;' and 'L'Année Géographique' of V. de Saint-Martin. The second edition of Kiepert's 'New Hand-Atlas of all Parts of the World,' in forty-five sheets, is worthy of mention, on account of its accuracy, clearness, fullness, and cheapness.

Proceedings of the Royal Geographical Society.

At several meetings of the Society since our last report the probable fate of Dr. Livingstone was discussed, a subject which our readers will find fully treated elsewhere. The first paper we have to notice is one by Admiral A. Boutakov, of the Russian navy, who has since received the Founder's Medal for the discoveries therein described. The gallant traveller surveyed the Delta of the Oxus, in the Sea of Aral, and was the first to launch a boat in that little-known lake. If we are ever justified in arguing from silence, this lake did not exist in so-called historic times, that is to say, during the period in which we have authentic works on geography, &c., written in Europe. No description of this sea occurs in European writers, nor did Asia furnish writers who could give details sufficiently explicit. In the way of positive testimony in the other direction, the Oxus and Jaxartes are said by Arabian geographers from the 13th to the 15th century to empty themselves into the Caspian, though previously the sea of Aral existed much as it does now. The several mouths of the Oxus all appear to be extremely shallow, and to afford but small advantages to a commerce that would at all times be liable to be interrupted by hostile tribes.

A map of Chinese Tartary, founded on the Russian surveys and on the map of caravan routes made by Colonel Walker, of the Indian Trigonometrical Survey, was exhibited by Captain Sherard Osborn, who also added a description of the country as far as it is at present known. It divides itself into three principal divisions—Manchuria, Mongolia, and Ili, or Eastern Turkestan. The former of these belongs in part to the Russians, who in all probability will get the whole before very long, when they will be better able, by means of the various river valleys, to communicate with the set-

tlements on the coast and with the eastern seas, from which they are now cut off by a range of mountains. Mongolia is at present the home of Mussulman cut-throats who overrun the neighbouring provinces, unchecked by the supineness of the Chinese Government. The third portion, Ili, is divided by a range of mountains. This district, interesting from the many ancient cities to be found within its borders, approaches that region of Central Africa which promises most to the enterprising traveller. In these regions the advancing powers of Russia and England will some day meet, and it remains to be seen whether, advancing gradually as the countries throw themselves into our hands, we may meet as friendly allies, warring alike and in common against Oriental tyranny and iniquity, or whether with the grasping spirit engendered by too great a devotion to commerce we coerce unwilling tribes and with unsettled borders encounter a warlike nation ready to wrest our ill-gotten gains from our hands. Other papers that have been read lately have been:—"A Trip to the Sources of the Sutlej," by Captain H. U. Smith and Mr. J. S. Harrison, M.A.; "On Part of Mesopotamia contained between Sherial-el-Beytha, on the Tigris, ten miles N.W. of Baghdad, to the large mound Tel-Ibrahim, nearly in the centre of Mesopotamia, nineteen miles N.N.E. of Hillah," by Lieutenant J. B. Bewsher; "On the Discovery of the Sources of the Lycus, the site of Nicopolis and other places in Kurdistan," by Mr. Consul Taylor; "A Description of Diarbekr," by Mr. R. J. Garden.

The anniversary meeting of the Society took place on the 27th of May. The report of the year describes the increase in the number of Fellows, and consequently of funds, the large additions to the library, both in the way of books and of maps, and the mode in which various sums had been expended in the advancement of geographical science. The Founder's Medal was bestowed on Admiral Alexis Boutakov, of the Russian Imperial navy, whose researches on the Sea of Aral are epitomized above, and the Victoria or Patron's Medal was given to Dr. I. I. Hayes for his researches in Arctic regions, where he reached a point farther north than any of his predecessors on land. In a simple, unpretending manner these researches are chronicled in his work on the 'Open Polar Sea.'

The President's Address was chiefly occupied with what has taken up so greatly the time of the Society during the present session, *viz.* the discussion of the probabilities in favour of the life or death of Dr. Livingstone, as reported by the man Moosa.

8. GEOLOGY AND PALÆONTOLOGY,

(*Including the Proceedings of the Geological Society.*)

An account of a most important work, entitled 'Thesaurus Siluricus,' was read by its author, Dr. Bigsby, before the Royal Society, on February 21st, and has since been published in the Society's 'Proceedings.'* This 'Thesaurus' is a catalogue of all the fossils which have been described from Silurian deposits in all parts of the world, and gives the range of each species in space and time. In the summary of results now made public are many facts and conclusions which are important, and some which are curious; but all are interesting. We thus find that there are 3,145 known American Silurian species and 4,325 European; but only 179 are common to the two regions. The Primordial Zone is the first formation in which anything like a *fauna* has been discovered, and in this deposit we suddenly become conscious of the creation of more than 900 species, belonging to a majority of the classes of the Invertebrata. Species are treated of by the author under two aspects, namely, (1) as being typical of one horizon; and (2) as "recurrent," or occurring in more than one. He finds that 12 per cent. of the whole number of species occur in more than one horizon, and that "the same species may be typical of one horizon in one country and recurrent in another." All these recurrents are, of course, within the limits of the Silurian epoch, and Dr. Bigsby treats of them as intra-epochal. Those species which pass into the Devonian period are termed extra-epochal, and he has been able to identify 42 which come under this head; and only one of these (*Chonetes sarcinulata*) is known to have survived in Carboniferous times. It is worth notice, also, that these extra-epochal recurrent species were of migratory habits,—"few being found in two epochs in the same country, but in different countries."

We are glad to learn that the Royal Society has granted 100*l.* towards defraying the cost of publishing this work, and we look forward to its appearance with some impatience. It is only by such laborious endeavours as this that we can hope to discover the laws which have regulated the appearance and extinction of species during geological time.

A very remarkable paper "On the Miocene Flora of North Greenland," by Professor Oswald Heer (translated by Mr. R. H. Scott) has been published in the Journal of the Royal Dublin Society. The collection of fossil plants described in the paper was brought from the Arctic regions by Captain Philip H. Colomb, R.N., and Sir Leopold M'Clintock, R.N., and contains 63 recognizable species. It is therefore quite trustworthy as to locality, and sufficiently

* Proc. Roy. Soc., No. 90, 1867, p. 372.

extensive to furnish valuable evidence as to climate. All the specimens, moreover, in this and other collections, came from one locality —Atanekerdluk,—which is in lat. 70° N., and were obtained from a deposit occurring at a height of 1,080 feet. Professor Heer is of opinion that the leaves "cannot have been drifted from any great distance," but that the plants grew on the spot where their remains are found. Three species had been previously mentioned by Brongniart and Vaupel, making with those now recognized a total of 66. Of these, 18 are found in the Miocene deposits of Central Europe, 9 being common to the Upper and Lower Molasse, while four species have not as yet been noticed in the Upper Molasse. The author therefore infers "that the fossil forest of Atanekerdluk flourished in that high northern latitude at the Lower Miocene Epoch," and that North Greenland had a much warmer climate during the Miocene period than it has at present. The extent to which the present temperature of the region would have to be raised, to render possible the existence there of such plants as those described in the paper, is estimated by Professor Heer at about 30° F. Most stress is laid on the presence in the collection of two species of *Sequoia*, one of which (*S. Langsdorfii*) is found fossil in as low a latitude as that of Central Italy, and is the commonest tree at Atanekerdluk; it is also "so closely allied to the *Sequoia sempervirens* of Lambert (the 'Redwood'), that we may consider the latter as its lineal descendant." Now this tree, we learn, "requires for its existence a summer temperature of at least 59° or 60° F., and for the ripening of its fruit and seeds one of about 64°." The winter temperature must not fall below 31°, and the mean annual temperature must be about 49°. The climate of Greenland must therefore have been at least as warm as that of Lausanne, and was probably somewhat warmer. These facts are at the present time of peculiar importance, and are recognized as being so by Professor Heer, who avows his belief "that it is impossible, by any re-arrangement of land and water, to produce for the northern hemisphere a climate which would explain the phenomena in a satisfactory manner;" and he concludes his paper with the remark "that we are here face to face with a problem whose solution, in all probability, must be attempted, and we doubt not completed, by the astronomer."

In a paper "Ueber die Parallelisirung des norddeutschen, englischen, und französischen Oligocäns, published in the last number of the 'Zeitschrift' of the German Geological Society, Herr von Koenen returns to the discussion of his favourite topic, for the purpose of disputing the conclusions arrived at by M. Hébert in a paper on the Nummulitic beds of Northern Italy, published last year in the 'Bulletin' of the Geological Society of France. The two papers may be taken as respectively typical of the German and French schools of Tertiary geologists; but until we have some

generally accepted principles of Tertiary classification, it will be impossible to come to any agreement on the subject of the German Oligocene, which we have already discussed in this Chronicle on several occasions.*

In the last volume (vol. xix.) of the 'Mémoires de la Société de Physique et d'Histoire Naturelle de Genève,' MM. de Loriol and Pellat have published an elaborate essay, entitled "Monographie paléontologique et géologique de l'étage portlandien des environs de Boulogne-sur-Mer," in which is given a complete history of the events which, according to the views of the authors, took place during the deposition of the Portland Oolite. It is especially worthy of remark that they regard the "Portlandien inférieur" of the eastern districts as synchronous with the Lower and Middle Portlandien of the Boulonnais; that is to say, that a Lower Portland fauna continued to live in the eastern regions after the fauna of the Portland stone of England, and its equivalents in the Boulonnais and the Pays de Bray, had supplanted it in the west.

In the 'Bulletin de la Société géologique de France' (vol. xxiv. No. 2) M. Thomas records the discovery of a lower jaw of Rhinoceros in the Upper Eocene of Tarn, near Gaillac. The author states that this genus has not hitherto been found in beds more ancient than the Miocene; and he demonstrates the greater antiquity of those in question, by showing their connection with the deposits of the basin of the Agout, where M. Noulet has discovered remains of *Lophiodon Lautricense, Palæotherium magnum, Paloplotherium minus,* and *P. annectens.* He regards this Eocene species as being very nearly allied to, if not identical with, the *Rhinoceros minutus* of Cuvier. It may be useful to remark that remains of *Rhinoceros* had previously been obtained from Eocene deposits in more than one locality in France, although M. Thomas seems to have been unaware of the fact.

The Geological Commission of Portugal has recently published two important volumes. Of one, entitled 'Descripção do solo Quaternario das Bacias Hydrographicas do Tejo e Sado,' by M. Carlos Ribeiro, we can only say that it is a very exhaustive treatise on the various Quaternary deposits of the valleys of the Tagus and the Sado, some of which have yielded remains of human industry. The other is, so far as we know, the first palæontological work of importance ever published in Portugal, and is entitled 'Gasteropodes dos depositos Terciarios de Portugal,' by M. Pereira da Costa. As the descriptions of the other fossils are to be published afterwards, the author reserves his conclusions until the completion of the work; but it is noteworthy, that he finds it necessary to preface this part with an introduction describing the objects of Palæontology, and the course he has adopted in his descriptions of the fossils. Both works

* Quart. Journ. Science, No. iii., p. 480; No. ix., p. 100; No. x., p. 279.

are printed in double columns, of which one is in the Portuguese language, the other being a translation in French.

We have pleasure in recording the publication of the text to the volume of plates forming Part I. of M. Barrande's "Cephalopodes Siluriens de la Bohême," which we noticed in our Chronicle in No. IX.

In the 'Annales des Mines' (vol. x.) is a welcome note on the "Geology of the North of Madagascar," by M. E. Guillemin, from which we learn the existence of a coal-bearing series of deposits on the north-west coast belonging to the Carboniferous formation, and probably to the Mountain-limestone; but it appears that the beds of coal seen by the author are of inconsiderable thickness.

In a report by Dr. Sterry Hunt and Mr. A. Michel, of the Geological Survey of Canada, on the Gold-region of Hastings, Upper Canada, the occurrence of gold in rocks of Laurentian age is proved beyond a doubt. This discovery still further enlarges the list of gold-bearing formations, but as we cannot find any expression of opinion by the authors as to the geological period of the impregnation, this the more scientific aspect of the question is left open.* The gold has been found in "three different associations: first, in the black carbonaceous matter; second, in the reddish ochery (*sic*) oxyd of iron, which is found in the same crevices as the latter; and third, in plates in the midst of crystalline ferriferous bitter-spar." These relations are no doubt very singular, and are thus explained by Dr. Sterry Hunt: the black matter, probably in the form of bitumen, was "first introduced into the fissures, which were subsequently filled with the ferruginous bitter-spar, whose deposition was contemporaneous with that of the gold," and whose decomposition no doubt yielded the ochreous oxide of iron.

In the March number of the 'Geological Magazine' is a paper by Mr. Rofe, giving some collateral evidence on the subject of escape of fire-damp, derived from observation of the escape of gases from wells (especially "blowing wells") during different conditions of atmospheric pressure. His conclusion "that coal proprietors should take especial notice of any considerable fall in the barometer, and at such times force an extra ventilation," &c., is perfectly sound, but already well known to managers of collieries. The real difficulty seems to be, how to suddenly augment in any considerable degree the quantity of pure air circulating in the mine.

There is also a paper on the Arenig and Llandeilo groups, by the late Mr. Wyatt Edgell, in which that very promising geologist has endeavoured to show that the Llandeilo Flags can be separated naturally into two groups, which he proposes to call "Upper Llandeilo" and "Lower Llandeilo" respectively, the Arenig group

* For a résumé of facts and opinions on this subject, see Quart. Journ. Science, No. xiii., p. 116.

underlying the latter, and also containing a distinct fauna. Three other interesting papers we can merely mention: (1) "On the relative Ages of the Boulder-clays," by Mr. George Maw; (2) "On the Secondary Cycadean Fruits of Britain," by Mr. W. Carruthers; (3) "On Lower Silurian Fossils," by Mr. H. A. Nicholson.

In the April number are six papers: Professor M'Coy records the occurrence of the genus *Squalodon* in the Tertiary deposits of Victoria, Australia, as being a further proof of the Miocene age of those beds; Mr. Carruthers describes an Aroideous Fruit (*Aroides Stutterdi*) from the Stonesfield slate; Mr. Powrie gives a description of the genus *Cheirolepis;* Mr. E. Ray Lancaster describes a new genus of Cephalaspidian Fishes (*Didymaspis*) from the Passage beds of Ledbury; Mr. J. Saunders gives some notes on the Geology of South Bedfordshire, made during examinations of the new cuttings on the Midland Railway; and the Rev. Mr. Gunn, in a paper on the Anglo-Belgian Basin, gives a theoretical sketch of the physical features of the country inhabited by the mammals whose remains are found in the Forest-bed of Norfolk.

In the May number is an important paper by the Rev. O. Fisher, "On the Ages of the 'Trail' and the 'Warp,'" in which the author enters into a discussion of the theories of M. Adhémar and Mr. Croll, which, coming from a mathematical geologist, will be appreciated by all who take an interest in the subject. He considers that the Palæolithic period was more ancient than the formation of the "trail," and formed "some part of the interval between 100,000 and 200,000 [years] before A.D. 1800." Then, after the Glacial era of the "trail," followed a period of equable seasons, of about 80,000 years' duration, "which would have been that of the submarine forests and their occupants." After this came the period of the "warp"—"a short period of severe winter cold;" and, finally, the period of the last submergence of our valleys had passed away about 8,000 years ago. The other papers in this number are "On a Cycadean Stem from Potton, Beds," by Mr. Carruthers; "On the May Hill Sandstone," by Mr. Salter; and "On Valley Terraces," by Col. Greenwood.

Amongst the correspondence we notice a continuance of the discussion on Hydrothermalism between Mr. David Forbes and Mr. James Geikie; and we are glad to find that the former has resolved the doubt which we expressed in our last Chronicle, by stating that "Notwithstanding my distinct statement *to the contrary*, Mr. James Geikie seems determined to make the object of my communication appear as a declaration against hythrothermal action."

Proceedings of the Geological Society.

A large portion of the last number of the Society's Journal is taken up with the Annual Report and the Address of the President (Mr. W. W. Smyth). The former contains nothing specially worthy of notice; but the Address is a valuable resumé of modern opinions on questions of Chemical Geology, which the President's high reputation invests with exceptional importance. The origin of serpentine, for instance, is a question which has for many years occupied the attention of petrologists, and Mr. Smyth brings together the chief facts and arguments in support of the several theories which deserve consideration. Among those who demur to the igneous origin of serpentine, two principal views may be discerned. That held by the majority is that generally serpentine has been derived from a "decidedly crystalline unstratified rock, in which the constituents are augite, or hornblende, and a felspar; whilst a few investigators, chiefly, however, for a special region, term it an indigenous rock, as having been altered *in situ* from a sea-borne sediment." Mr. Smyth, like most petrologists, takes exception to Dr. Sterry Hunt's view that the silicated minerals in which the structure of *Eozoon* has been preserved "have been formed, not by subsequent metamorphism in deeply buried sediments, but by re-actions going on at the earth's surface." The President likewise discusses at some length M. Daubrée's memoir on Meteorites, especially with reference to the original condition of the earth, and contrasts the results of that author's experiments with the unsupported *dicta* of M. Friedrich Mohr in his work entitled 'Geschichte der Erde.'

The part devoted to the Proceedings of the Society commences with an important paper, by Professor Huxley, on a new specimen of *Telerpeton Elginense*, in which the author shows "that this animal is one of the Reptilia devoid of the slightest indication of affinity with the Amphibia." Professor Huxley further refers it to the sub-order Kionocrania of the true Lacertilia, which contains all the modern Lizards. This conclusion of course renders it more probable than ever that the age of the deposit in which it is found, associated with *Stagonolepis*, *Hyperodapedon*, &c., is Trias and not Old Red Sandstone; and we have recently learnt that further confirmation of the Mesozoic age of the strata has been obtained by the discovery of one of its associates in Warwickshire.

Mr. S. V. Wood, jun., in the next paper, describes a section at Litcham exhibiting contorted and broken layers of chalk and flint bands, as affording evidence of Land-glaciation during the earlier part of the Glacial period in England. This is followed by a paper, by Mr. F. W. Harmer, "On the Existence of a Third Boulder-

clay in Norfolk," which he considers to be more recent than the true Boulder-clay, and even than the plateau-gravel of the district.

In an important paper "On the Age of the Lower Brick-earths of the Thames Valley," Mr. Boyd Dawkins grapples with a subject which has been a fertile source of discussion since the year 1836. These deposits were considered by Dr. Falconer to be anterior in age to the Boulder-clay, and by Mr. Prestwich to belong to the Low-level series of Quaternary deposits. The sections at Ilford, Grays Thurrock, Crayford, and Erith all show the following deposits in ascending order: (1) the fluviatile brick-earths and gravels, whence the Mollusca and Mammalia are derived, and which are remarkable for the horizontality of their bedding and the even sorting of their component parts; (2) the "trail" of Mr. Fisher, of a highly confused nature, and as remarkable for the contortion of its bedding as the deposits below are for their horizontality; (3) the surface-soil resting on the uneven summit of the preceding. These three deposits indicate three epochs: First, that of the brick-earths, in which the water was unencountered by floating ice; then that of the trail, which is probably a mere icewash formed under a glacial climate; and lastly, the rainwash, formed under temperate conditions. The presence of *Elephas priscus* and *Rhinoceros megarhinus* indicates the affinity of this group of deposits to those of Preglacial age on the Norfolk shore, and to the foreign Pliocenes. The tichorhine and leptorhine Rhinoceroses, on the other hand, point towards deposits of clearly defined Postglacial age. The preglacial Trogonthere, *Rhinoceros etruscus*, *Elephas meridionalis*, *Sorex moschatus*, and *Cervus dicranios* are absent on the one hand, the entire group of Postglacial Arctic Mammalia on the other; and especially among these latter the Reindeer. The Lower Brick-earths therefore afford remains in part peculiar to the forest-bed of Norfolk and the Pliocenes of France and Italy, and in part to the Postglacial deposits, and probably occupy a middle point in time between the two, being more modern than the former and more ancient than the latter. For these reasons the author suggests the following classified list of Pleistocene deposits: (1) Forest-bed of Norfolk—climate temperate; (2) Lower Brick-earths of the Thames Valley—climate temperate; (3) Glacial deposits—climate severe; (4) Postglacial deposits—climate severe, but gradually becoming temperate.

Mr. Maw's paper "On the Occurrence of Consolidated Blocks in the Drift of Suffolk" is a contribution to the evidence on the geological position of the blocks of saccharoid sandstone which are found scattered on the surface of many parts of the chalk-districts, and which appear to have been derived from several formations of different ages. In the author's opinion the blocks now treated of,

many of them several tons in weight, were formed by the consolidation *in situ* of the loose drift in which they occur.

There is also a "Geological Description of the First Cataract, Upper Egypt," by Mr. J. C. Hawkshaw, which is worthy of study by those interested in the Geology of the Nile Valley.

9. MINERALOGY, MINING, AND METALLURGY.

Mineralogy.

Under the name of *Ekmanite*, Herr Igelström describes* a new mineral from the iron mine of Brunsjö, in Grythyttan, Government of Örebro, Sweden. The mineral occurs in veins and bands, penetrating the magnetic ore which forms the object of exploration in the mine. Several analyses lead to the general formula:—

$$2\,(2\,RO,\,Si\,O_3) + 3\,HO,$$

where RO represents the protoxides of iron, manganese, and magnesia. The name has been given in honour of the well-known Swedish iron-master, Herr G. Ekman.

Early in 1865 a peculiar mineral, at that time regarded as a silver-ore, was discovered in the Blind Spring Mountains, Mono Co., California. It occurs in irregular deposits, associated with argentiferous galena, and presents the appearance of a compact lustreless substance, varying in colour from yellowish-green to black, and having a hardness of from 3 to 4, and a specific gravity of 3. Mr. Albert Arents, of Mono, has recently analyzed this supposed silver-ore, with the following results:—

Teroxide of antimony	47·65
Protoxide of copper	32·11
„ „ silver	6·12
„ „ lead	2·01
„ „ iron	2·33
Water	8·29
	98·51

From this analysis, the mineral is evidently an antimonite of various protoxide bases expressed by the following formula:—

$$3\,(Cu\,O,\,Ag\,O,\,Pb\,O,\,Fe\,O)\,Sb\,O_3 + 3\,HO.$$

The mineral is, therefore, a new species, for which Mr. Arents proposes the name *Partzite*, after its discoverer, Dr. Partz.

Some doubts have since arisen as to the propriety of regarding the mineral in question as a distinct species; but Mr. Arents has met the objections by showing that the observations on which they

* Das neue Mineral Ekmanite. Berg-und Hüttenmännische Zeitung, 1867. No. 3, p. 21.

rest must have been made, not on the Partzite itself, but on the main body of the Blind Springs ore.*

Few men have a better right to speak on the chemical origin of minerals and rocks than Dr. Sterry Hunt, of the Geological Survey of Canada. This indefatigable chemist has recently laid before the French Academy of Sciences his views "On the Formation of Gypsums and Dolomites."† Alluding to his former researches, Dr. Hunt shows that the reaction of a solution of bicarbonate of lime on sulphate of magnesia gives rise to the formation of sulphate of lime and bicarbonate of magnesia. It is, however, extremely difficult to obtain, on evaporation, a complete separation of the two salts produced by this double decomposition; for the bicarbonate of magnesia on exposure to the atmosphere loses a portion of its carbonic acid, and passes to the condition of a neutral or a sesqui-carbonate, which easily decomposes the sulphate of lime, reproducing carbonate of lime and sulphate of magnesia. To obviate this loss of carbonic acid, Dr. Hunt conducts the evaporation in an atmosphere highly charged with carbonic acid; such an atmosphere effectually preventing the decomposition of the bicarbonate, and allowing the gypsum to separate in a pure crystalline form. To apply these laboratory experiments to the explanation of the natural origin of gypseous and dolomitic rocks, the author has recourse to the opinion still entertained by some geologists, that the proportion of carbonic acid in the atmosphere must have been much greater in the earlier periods of the world's history than at the present time. This admitted, his experiments afford a simple explanation of the formation of beds of gypsum, and also of the magnesio-calcareous rocks with which they are commonly associated. The water of most natural springs holds in solution more or less bicarbonate of lime, which, when carried down to the sea, reacts on the sulphate of magnesia present in sea-water, producing sulphate of lime and bicarbonate of magnesia; and the water containing these mixed salts, on evaporation in a basin of limited area and under an atmosphere rich in carbonic acid, deposits the sulphate of lime in the form of gypsum, while the magnesian carbonate, uniting with carbonate of lime, may be precipitated as a dolomitic sediment.

At a subsequent meeting of the Academy, Dr. Hunt followed up the subject in a paper "On Certain Reactions of Magnesian Salts, and on Magnesia-bearing Rocks."‡

The same eminent chemist gives the result of much philosophical thought in a memoir "On the Objects and Method of

* 'San Francisco Mining Press,' 1867, Jan. 19, Feb. 9, and April 13.

† "Sur la Formation des Gypses et des Dolomies:" 'Comptes Rendus,' 1867, No. 16, p. 815.

‡ "Sur quelques Réactions de Sels Magnésiens et sur les Roches magnésifères:" 'Comptes Rendus,' 1867, No. 17, p. 846.

Mineralogy," read before the American Academy of Sciences.* The author advocates the extension of mineralogical science, so as to embrace the entire range of inorganic substances whether occurring native, or produced by the chemist's skill; and then, passing to the great problem of classification, discusses the objects of a "natural system" and the basis upon which it must be founded. "Such a classification," says Dr. Hunt, "will be based upon a consideration of all the physical and chemical relations of bodies, and will enable us to see that the various properties of a species are not so many arbitrary signs, but the necessary result of its constitution." Not until this shall be accomplished, at least in a measure, can mineralogy expect to take equal rank with the kindred sciences of systematic botany and zoology.

Mr. T. Davies, of the British Museum, calls attention to the occurrence in Cornwall of the rare oxide of antimony called *Senarmontite*. The mineral occurs in opaque octohedral crystals lining a cavity in a specimen of Jamesonite from Endellion.†

Every mineralogist is familiar with the calcite-shaped crystals from the Fontainebleau sandstone. Somewhat similar groups of crystals have recently been found in a valley near Heidelberg, and have been described by Professor Blum.‡ They occur in the centre of certain irregularly-shaped sandstone nodules, which have been weathered out from the Bunter Sandstone of the surrounding rocks. The crystals present the scalenohedral form of calcite, but consist entirely of sandstone. Professor Blum supposes that the calc-spar originally crystallized in the midst of loose sand, which afterwards concreted around the crystals, forming a solid mass; the enclosed calcite being subsequently removed by the percolation through the external sandstone of water holding carbonic acid in solution, and its place supplied by the deposition of silica, which had served as a cementing medium to the sandstone. Occasionally a cavity exists between the investing and the enclosed sandstone; but originally the sandstone must have closely covered the calcite, since it bears the sharp impression of its crystals; the space, therefore, between the kernel and its shell shows that the quantity of silica introduced was insufficient to entirely replace the carbonate of lime which had been removed.

Dr. How's "Contributions to the Mineralogy of Nova Scotia" are continued in the 'Philosophical Magazine' for May.§ Several analyses are given of certain dark-coloured pebbles found at Cornwallis, King's Co.; and although the results show that the com-

* 'Silliman's American Journal of Science and Arts,' March, 1867, p. 203.
† 'Geological Magazine,' April, 1867, p. 192.
‡ Bunter Sandstein in Formen von Kalkspath. Leonhard's Jahrbuch, 1867. Heft III., p. 320.
§ 'Phil. Mag.,' May, 1867, p. 336.

position is by no means uniform, sufficient evidence is obtained to refer the mineral to the rare species *Wichtyne*. The Professor then describes three argillaceous rocks, apparently of local interest only; and, finally, notices the occurrence of bitumen on calcite in Inverness Co., Cape Breton.

It is not a little remarkable that there should be on record but comparatively few analyses of so common a mineral as iron pyrites. M. Mène has, therefore, done good service by undertaking a complete chemical examination of the mineral, the results of which are published in a "Note on Yellow and White Iron Pyrites."* The value of this short memoir will be appreciated by remembering the amount of labour represented by the thirty-six original analyses which it contains. The author calls attention to the fact, brought out by these researches, that the ordinary yellow cubic pyrites contains much less water than does marcasite, or white rhombic pyrites; and that the difference in the stability of the two species on exposure to atmospheric influences may be referable to the varying amount of argillaceous impurities present.

Some time back, Mr. J. P. Cooke, jun., described a new American mineral, called Danalite, occurring in the granite of Cape Ann, Massachusetts. Associated with this are two remarkable micas, one of which is a variety of Lepidomelane, while the other appears to be a new species, which, from its easy fusibility and its foliated structure, has received the name of *Cryophyllite*.† This mineral, like the other micas, crystallizes in six-sided prisms belonging to the rhombic system, and has a perfect basal cleavage. The crystals are optically biaxial, and are dichroic, presenting a dull-green colour when viewed in the direction of the principal axis, and a reddish brown when examined transversely. The spec. grav. is 2·909, and the hardness varies from 2 to 2·5. The large amount of alkalies present, amounting to 13·15 per cent. of potash and 4·06 of lithia, seems sufficient to account for the extreme fusibility of the mineral.

The composition of *Boronatrocalcite* or *Natroborocalcite* has recently been the subject of some discussion.‡ There seems good chemical reason for accepting the formula which Dr. Lunge has established from his carefully conducted analyses, and which may be thus expressed:—

$$2\,(Na\,O,\,2\,BO_3) + 5\,(Ca\,O,\,2\,BO_3) + 42\,HO.$$

For some time past, Professor Graham has been engaged in a

* "Note sur les Pyrites de Fer jaunes et blanches:" 'Comptes Rendus,' 1867, No. 17, p. 867.

† "On Cryophyllite, a new mineral species of the Mica family:" 'Silliman's American Journal,' March, 1867, p. 217.

‡ See 'Annalen der Chemie und Pharmacie,' Bd. cxxxviii., p. 51; cxxxix., p. 52; cxli., p. 379; and 'Chemical News,' 1867, Feb. 22nd; April 9th; and April 26th.

series of researches on the absorption of gases by metals; and, quite recently, these investigations have, in a most unexpected manner, yielded results which promise to throw considerable light on the origin of meteorites. His experiments have shown that many metals, when heated in certain gaseous media, are capable of absorbing a large volume of the gas which may be retained at ordinary temperatures, for an indefinite period, condensed within the interstices of the metal, but ready to be evolved at any moment by a sufficient elevation of temperature; this power being denoted by the term "occlusion." Pure iron, for example, heated to low redness in carbonic oxide, occludes upwards of four times its volume of the gas; and hence a piece of ordinary wrought iron heated *in vacuo* yields a considerable amount of carbonic oxide derived from the atmosphere of the furnace in which it was prepared. It became, therefore, a matter of much interest to determine whether meteoric iron contained any, and if any, what kind of occluded gas; and experiments were accordingly made with the Lenarto meteorite. When a carefully cleaned piece of this iron is heated in a tube connected with the exhausting apparatus known as "Sprengel's pump," it yields 2·85 times its volume of gas, having the following composition:—

Hydrogen	85·68
Carbonic oxide	4·46
Nitrogen	9·86
	100·00

Now since the occluded gas is in every case a remnant of the atmosphere in which the metal was last ignited, the conclusion seems almost inevitable that the meteorite in question must have been intensely heated, before reaching our earth, in a dense atmosphere highly charged with hydrogen,—a conclusion which receives additional interest when studied in connection with Messrs. Huggins and Miller's researches on the stellar spectra, and with the Father Secchi's recent attempt to classify the fixed stars according to their spectra, hydrogen being the characteristic element in those of which α Lyræ is the type. The discovery has been communicated to the Royal Society by the Master of the Mint, and has been brought before the audience of the Royal Institution by Dr. Odling.

M. Dumas has called the attention of the Academy of Sciences of France to a peculiar substance, the origin of which is unknown, which possesses the general character of anthracite, but approaches the diamond in hardness. Attention has been especially directed to this, hoping that the source from which it has been derived may be discovered, and the peculiarities further examined.

Dr. Schrauf, of the Imperial Museum of Vienna, has communicated to the Academy* the correction of the weight of the great

* Sitzungsb. d. k. Ac. d. Wiss., Bd. LIV., p. 5.

Austrian diamond called "Florentine," which has been made by the commission appointed to examine it.

According to the Imperial inventory, the stone weighs 133⅛ carats, whilst in all works on precious stones the weight is given as 139½ carats. The recent examination of the gem shows its specific gravity at 19° Cent. to be 3·5213, and its weight, 27·454 grammes. Now the value of the carat is:—

In Amsterdam	205·7000	milligrammes
„ Florence	197·2000	„
„ Paris	205·5000	„
„ Vienna	206·1300	„

Therefore the newly-determined weight, 27·454 grammes, corresponds to 139⅛ Florentine carats, 133⅜ Paris carats, and 133·180 Vienna carats. The last number, corrected for weighing in air, gives 133·160 Vienna carats as the true weight of the famous Florentine.

Mining.

The Select Committee on Mines continues its sittings. Several of the Colliery Inspectors have been examined. It is evident from the tenour of nearly all the questions that the members of this Committee are inclined to recommend an additional number of Inspectors, and possibly the introduction of sub-Inspectors.

There is a great objection to the latter; an inferior class of men would be placed in positions of considerable responsibility, and they would not be enabled to exert any beneficial influence over the men. Any attempt to remove the responsibility from the coal owner and his agents will be replete with danger.

Another Committee deals with the question of Mines Assessment, admitting in the abstract, the correctness of the principle of rating mines to the poor; it is unfortunate that any additional burden should now be thrown upon our mineral industries. A very mistaken idea prevails, arising mainly from the want of practical acquaintance with the subject; many persons conceiving that since the mines draw a population to a parish, and thus in the course of time throw many burdens on it, that justice demands from them their contributions towards the support of that poor. The result at this time, if the Bill introduced by Mr. Percy Wyndham should become an Act, would be that a large number of mines which are now working at a considerable monthly loss, and which are continued hoping for an improvement in the metal market, for the purpose of keeping the miners employed—as if once dispersed they would never again be gathered together—would be abandoned, and thus hundreds of families thrown heavy burdens on the parishes. Under more favourable aspects there would be but little

objection on the part of the mine proprietors to an equitable system of rating.

The Committee at their last meeting carried the following resolution by a majority of 7 to 4:—

"Provided always that after the passing of this act no occupier of any mine within the jurisdiction of the Stannary Courts of Devon and Cornwall, or of the High Peak Mining Customs and Mineral Courts Act (14 and 15 Vic. c. 94), and the Derbyshire Mining Customs and Mineral Courts Act (15 and 16 Vic. c. 163), shall be liable to be rated to the relief of the poor, to the county and highway, and other local rates, and no assessment shall be made on such mines, otherwise than on the owner or owners in respect of the rent, royalty, toll, or due reserved to him or them."

It now remains to be seen whether the House of Commons will accept the amended bill.

The present condition of the Tin and Copper Mines of this country will be best understood by the following statement of facts.

In 1860, 405 mines paid dues upon the ores raised to the Stannary Court. In 1866, they were reduced to 315. The value of all the ores upon which those dues were paid was in 1861 2,068,123*l.*; whereas in 1866 it was only 1,404,462*l.* In 1861, the number of Cornish and Devonshire Mines paying dividends amounted to fifty-eight; but in 1866 there were but twenty-six mines which paid dividends. With two or three exceptions the dividends were small, and in some of the mines it was deemed prudent to pay the dividend out of the reserved funds, as widows and orphans were entirely dependent on them for their subsistence. Within the last eighteen months about 11,500 persons have been thrown out of employ; and of these above 7,000 have left the Western counties. Six thousand have emigrated to America, to Australia, and New Zealand; the others having found employment in the collieries of Scotland, and a few on the lines of railway now in process of construction.

Safety Lamps have been made the subjects of a series of most carefully contrived experiments by some of the colliery engineers of the Newcastle district, and the result has been to show that none of the lamps at present in use, under the circumstances to which they are exposed in *well-ventilated* collieries, are *safe*. The experiments were made after the following manner. The safety lamp under trial was placed in a wooden pipe, through which any mixture of gases and atmospheric air could be driven at any velocity, the rate being measured by Dickinson's or Biram's anemometer. It was found when an explosive mixture of carburetted hydrogen and atmospheric air—fire-damp—was made to travel the pipe at a velocity of 8 feet per second, the ordinary Davy Lamp began to heat, and in a few moments it exploded *out-*

side. It appears that the "Georgie"—that is Stephenson's lamp—and Clanney's, were not found to be any safer than the Davy; and the Belgian lamps Eloin's and Mueseler's were equally liable, under certain conditions, to explosion. A few years since those lamps were what they professed to be—with the currents of air travelling at the rates which were then common, there was nothing to be apprehended. Ventilation has been greatly improved, and the quantity of air now driven through a colliery is nearly double that which was considered necessary a few years since. Consequently a lamp is now exposed, especially in our best collieries, to a current having twice the velocity of the air to which it was formerly exposed. This improved rate of ventilation renders, according to the experiments at the Hetton colliery, all existing safety lamps dangerous whenever an atmosphere of fire-damp prevails. These experiments must be repeated under all conditions; and the safety lamps, which are evidently correct in principle, must be modified to meet the improved conditions of ventilation.

Such paragraphs as the following are from time to time appearing in the newspapers relative to the extension of our coal-fields.

"The question as to whether coal may not be found under other formations than those acknowledged and defined, is having a practical solution in the extreme south of Derbyshire, at a point where it *has been laid down on the geological map as being free from anything of the kind.*" We are then told that at Coton Park, a few miles from Gresley, a wealthy proprietary are sinking in the expectation of reaching coal at a moderate depth; and the writer continues—"Should they be successful, of which there is a strong probability, the finding of the coal cannot but have an important bearing on the important question which the Royal Commission is now investigating as to the extent of our coal-fields."

If the writer of this had been at the trouble to consult the published evidence of the Geological Survey in regard to this very district, he would have found, upon Horizontal Section, No. 52, a well-defined plan of the strata and of the faults by which it has been disturbed, with the following remark—"*The coal-measures of this area have not been proved, but the coal seams probably rise towards the west under the New Red Sandstones, and in any case their depths are influenced by the faults here marked.*" This certainly does not confirm the writer's statement as given above, but it proves that the existence of coal over this area is well known, though the depth at which it will be found has yet to be determined.

A mine of Antimony of St. Mary-le-Plain, in the canton of Massiac, in the department of Cantal, Central France, which was

worked with some activity in 1860, and abandoned in 1865, has just been reopened, and workings are commenced with the promise of a thorough examination, and it is hoped of a satisfactory result. This mine is stated to produce native antimony, sulphide of antimony, or glance antimony, and the grey and red ores of this metal.

Mr. J. G. Williams, of Aberystwith, who has for many years been connected with the Lead mines of Cardiganshire, especially those which are in the Gogerdan property, has just published an interesting little work, called 'A short Account of the British Encampments lying between the Rivers Rheidol and Llyfnant, in the county of Cardigan, and their connection with the Mines.' Mr. Williams has instituted a careful examination of a considerable number of ancient encampments He finds some to be, as he considers, peculiarly British, others being Roman, or Roman-British; and their positions prove unmistakably that they were constructed for the purpose of protecting the mines adjoining them. Wherever there is a group of mines, Mr. Williams finds a group of encampments also. This is really a valuable contribution to the obscure history of early British Mining.

In connection with publications relating to Mining, we may state that we have seen the advanced sheets of a work 'On Gold and Silver Mining and Metallurgy in all parts of the World.' It is by Mr. John Arthur Phillips, a gentleman well known as the author of a 'Manual of Metallurgy,' and for his extensive acquaintance with the Mines of the Old and the New Worlds. The book is extensively and beautifully illustrated.

Dr. Clement Le Neve Foster, D. Sc., Lecturer to the Miners' Association of Devon and Cornwall, has translated from the Dutch Van Diest's 'Banca, and its Tin Stream Works,' which is decidedly the best account of this extraordinary stanniferous district which has appeared. It cannot but be of the greatest importance to the English Tin miners to know exactly the conditions under which the Dutch obtain the tin in their Eastern possessions. The Banca Tin being at the present time the most serious rival with which the British Tin miner has to contend.

Professor F. de Hochstetter has recently brought before the Imperial Geological Institute of Vienna an account of several "exploitations" for coal and iron in the Banat. The coal formation of Steierdorff, which was discovered in 1790, and which belongs to the Lias formations, has within the last few years been brought into notice. Five beds of coal have been worked upon, and they give a yearly production of 165,000 statute tons. This coal is known commercially as the coal of Orawieza, and is one of the best produced in the Austrian Empire as regards calorific power. Much of it is used for the steam navigation of the Danube, and for locomotive purposes on some of the railways. Gas is

manufactured from it at Pesth and Temesvar, and in many of the great industrial establishments of Hungary.

In connection with these coal beds considerable deposits of argillaceous iron ores are found, and overlying them beds of bituminous shales which are very rich in mineral oil, which is used, under the direction of Dr. O. Gomelin, in the manufacture of paraffine and photogene.

Professor Hochstetter remarks that the coal of this district competes, and not without success, with the British coal which finds its way to the Danubian Provinces. Sulphides of iron, lead, and zinc, are stated to be associated with the iron ores.

The demand for coal in France is rapidly increasing, and consequently we find an increase in the quantities of coal sent into that country from England and from Belgium. The quantities sent from the two countries being as follows:—

		Tons.		Tons.
1864	Belgian	3,150,185	English	1,285,514
1865	„	3,350,782	„	1,562,627
1866	„	3,785,711	„	1,904,091

The French Government, anxious to preserve the existing woods in France, are doing all they can to induce English coal-owners to send coal into that country, and the great railway companies have agents in England, making special inquiries as to the probable quantities of coal which may be sent into the interior of France if the railway rates are reduced.

It has been, not unfrequently, said, and very generally believed, that the Gold Mining of Australia was rapidly declining. The last number of Dicker's 'Mining Record,' an admirable weekly paper, published in Melbourne, and devoted to the consideration of the important mining interests of Victoria, gives in its share circular, the names of thirty-eight dividend alluvial mines and of thirty-six progressive alluvial mines; of sixty dividend quartz mines and of sixteen progressive quartz mines. This does not look like a failing of activity in gold washing or mining. Within sixteen years the two colonies of Victoria and New South Wales have produced a supply of gold amounting in value to 150,000,000*l.* sterling, four-sixths of which has been the produce of Victoria alone.*

We have just seen some very interesting specimens of Gold sent home from Otago, New Zealand, by Mr. William Warren, and some gems, topazes, amethysts, sapphires, rubies, rock crystal, and a remarkable siliceous gem of extreme hardness, which we believe to be new. We note this to show the importance of carefully examining the residues of the gold washings of this colony. The gems now sent are small and not of much value, but they indicate the high probability of finding such as would be of real value.

* See also article on "The Progress of Science Abroad," in the present number. 'Intercolonial Exhibition, 1866. Mineral and Mining Statistics.'

Welsh Gold Mining, which a few years since was of great promise, has almost entirely failed to be remunerative; but two mines produced any quantity of gold in 1866, Vigra and Clogan being one, and Castell Carn Dochan the other, and from the Quartz lodes of these mines about 1,200 ounces of gold were obtained.

Metallurgy.

There has been for some time an evident want of activity in our Metallurgical processes. The causes of this are sufficiently obvious. The unfortunate attitude assumed by the workmen—more unfortunate for their future than for the future of masters—and the general disturbance of trade being the principal ones. Resulting from this, we find but few of our great manufacturers exhibiting at Paris; but beyond the influence of trade depression, there is another influence yet more potent, which has prevented the display of the finer specimens of English manufacture. Exhibitions have not, as a rule, been found profitable. The regular system of the workshops has to be disturbed, and much inconvenience suffered, which the resulting advantages have not been found to balance. It is therefore most fallacious on the part of Dr. Lyon Playfair to assume that English manufacture is retrograding, because the display of our metallic industries at Paris is an imperfect one. A glance at the Catalogue will convince any one that our highest-class manufacturers have not exhibited. Yet Dr. Playfair, writing to Lord Taunton, thus expresses himself:—"I am sorry to say that with very few exceptions, a singular accordance of opinion prevailed that our country had shown little inventiveness, and made but little progress in the peaceful arts of industry since 1862. Deficient representation in some of the industries might have accounted for this judgment against us, but when we find that out of ninety classes, there are scarcely a dozen in which pre-eminence is unhesitatingly awarded to us, this plea must be abandoned. My own opinion is worthy only of the confidence which might be supposed to attach to my knowledge of the chemical arts; but when I found some of our chief mechanical and civil engineers lamenting the want of progress in their industries, and pointing to the wonderful advances which other nations are making, when I found our chemical and even textile manufacturers uttering similar complaints, I naturally devoted attention to elicit their views as to the causes."

It is not necessary to quote any further from Dr. Lyon Playfair's letter, which proceeds to inform Lord Taunton that the one great want of England is technical schools.

Dr. Playfair is exceedingly illogical. In the first place, his complaint is that "our country had shown little inventiveness since 1862;" and then he speaks of the "wonderful advances which other

nations are making." We must ask him, In what do those wonderful advances consist? Certainly not in inventiveness. For notwithstanding the want of activity in English manufacture and trade, we are so bold as to state that there has been more inventiveness shown in England since 1862 than in all the nations of Europe put together. If the "wonderful advances" refer to manipulatory details, we believe, in many cases—certainly not in all—Dr. Lyon Playfair will be right enough. But the absolute weakness of this letter, put forward with an air of authority which is not pleasant, consists in taking what is confessedly an imperfect display of British industry, as a fair example of the present power of the British workshops. In concluding his letter, Dr. Playfair says, "It would be important that the Government either through your Commission or through the Committee of Council on Education, should hold an official inquiry on this subject, and should tell the people of England authoritatively what are the means by which the great States are attaining an intellectual pre-eminence among the industrial classes, and how they are making this to bear on the rapid progress of their national industries."

In our Mineral and Metallurgical Industries to which especial reference is made, and to which we desire to confine ourselves, there is not, in the first place, that want of inventiveness which Dr. Lyon Playfair supposes; and in the second place, supposing it did exist, it would not be remedied by any authoritative telling of a Royal Commission or a Committee of Council.

Our iron furnaces are improving in construction and increasing in size. The iron made from inferior ores is greatly improving in quality. Our mills are now the finest in the world, and capable of executing any work for which there may be a demand. We are the only people in the world who are striving—and striving too with every prospect of success—to carry out the process of puddling by machinery; and where else shall we find coal cutting by machinery in so advanced a state as in the British coal fields?

In our processes of Lead Smelting great advances are being made—and from ores of lead containing copper, the best lead can now be manufactured. Indeed, in each of our metallurgical processes we can point to improvements which will show how exceedingly imperfect is the knowledge possessed by Dr. Lyon Playfair; and a little consideration would have prevented Earl Granville from basing his remarks,—made at the distribution of prizes at the London University,—on so fallacious a letter as that addressed to Lord Taunton.

An alloy of Platinum and Steel has been formed which possesses some peculiar properties. When these two metals are in a state of fusion, they alloy in all the proportions tried. This alloy takes a fine polish, does not tarnish, and its pure colour peculiarly fits it for a mirror. Its density is 9,862. If two pieces, one of steel and the

other the alloy of steel and platinum, be plunged into dilute sulphuric acid, the alloy is attacked with violence, while the steel remains untarnished. This alloy is thus attacked by acids in all proportions, until ninety parts of platinum with twenty of steel are united.*

Alloys of Silver and Steel were made long since by Stodart and Faraday, and then fully examined; our French friends have recently announced an examination of these argentiferous alloys as something new.

The Iron Sand of New Zealand is again attracting attention, and a company has been formed for working it. Let us hope that the experiment of making pig iron from this ore may be practically more successful than the former attempts to do the same thing has been.

M. Julien has presented to the Society of Encouragement of Paris a pamphlet on Iron and Steel, in which he puts forth some peculiar views on the combination, or rather mixture, of carbon and iron. The cleverness of this essay and its novel views will commend it to the attention of the man of science and to the steel manufacturer.

The manufacture of Steel Iron from Cinder Pigs, which has been for some time the subject of experiment, appears to be now nearly approaching a successful development. Mr. Heaton, of Langley Mills, places nitrate of soda at the bottom of the crucible and covers it with a perforated iron plate. The iron to be purified is placed above this, and the melted nitrate of soda diffuses itself through the melted metal, producing, according to the statement of the inventor, complete desulphurization and dephosphorization.

A number of experiments were made recently at Langley Mills with cinder iron, which would have been utterly useless in the Bessemer converters. The result is stated to have been the production of steel iron of the finest quality.

We understand that a large Staffordshire firm is preparing to make the experiment upon a large scale; we shall anxiously watch and report the result obtained.

10. PHYSICS.

Light.—Mr. Sorby, in this Journal, two years ago, described his application of Spectrum Analysis to microscopical investigations, and especially to the detection of blood stains. Mr. Browning has recently made for Mr. Sorby a modification of the spectroscope,

* 'Les Mondes,' tome xiii., 15 livraison.

which is intended to slip into the eye-end of a microscope, instead of the eye-piece.

The instrument contains a series of prisms arranged for viewing the spectrum by direct vision, and there is an arrangement for the purpose of obtaining a supplementary spectrum from any object whose spectrum it is desired to compare with that of the object placed on the stage of the microscope; which object may be either a solution of permanganate of potash in a small sealed tube, a cobalt-blue glass, or anything else which will furnish a standard spectrum for comparison. Milled heads with screw motions enable the observer to adjust the focus of the different parts of the spectrum and to open and shut the slit vertically and horizontally. Powers of from half-an-inch to 1-20th may be employed, and by using a binocular microscope the object may be brought into the field and examined in the ordinary way through one tube, whilst its spectrum may be observed and compared with that of a standard light by means of the other tube. The object may be illuminated either by transmitted or reflected light, and any of the ordinary accessories may be used for this purpose, such as achromatic condenser, side reflector, Lieberkuhn, &c. Mr. Sorby proposes the use of a standard interference spectrum, to be used as a scale in all descriptions of spectra, as seen by the spectrum microscope. The scale is produced by a plate of quartz ·043-inch thick, cut parallel to the principal axis of the crystal, and placed between two Nicol's prisms. By this means the whole visible space is divided by dark bands into twelve regular divisions, having in all parts the same relation to the physical properties of light. These are counted from the red end towards the blue, their centres being reckoned as 1, 2, 3, &c., and the thickness of the plate is so adjusted that the sodium line exactly corresponds to $3\frac{1}{2}$. The intensity of the absorption is expressed by the following types:—

Not at all shaded		(blank space)
Very slightly shaded	. . .	(dots with wide spaces)
Decidedly shaded	. . .	(dots closer together)
More shaded	...	(very close dots)
Strongly shaded, but so that a trace of colour is still seen	---	(three hyphens close)
Still darker	—	(single dash)
Nearly black	——	(double dash)

Except when specially requisite, only the symbols . . ., ---, —, are employed for the sake of simplicity, and then as signs of the relative rather than of the absolute amount of absorption, and it is assumed that there is a gradual shading-off from one tint to the other, unless the contrary is expressed. This is done by means of a small vertical line over the figure, which shows that there is a well-marked division between them. Definite narrow absorption-

bands are indicated by * printed over their centre. In Mr. Sorby's paper examples are given which show how simple or more complicated spectra may readily be printed and compared. For instance, the spectrum of normal chlorophyll dissolved in alcohol (deep green), is represented by:—

$$\frac{1}{8} \overset{*}{-} 2\tfrac{3}{8} \text{ --- } 3\tfrac{1}{4} \text{ .... } 4\tfrac{1}{2} \quad 6\tfrac{3}{4} \text{ --- } 7\tfrac{1}{2} -$$

and the spectrum of the same body, as decomposed by acids, as found in some leaves (olive green), by:—

$$1 \overset{*}{-} 2\tfrac{1}{8} \quad 2\tfrac{3}{4} \overset{*}{\text{---}} 3\tfrac{3}{8} \quad 4\tfrac{1}{4} \text{ ... } 5\tfrac{1}{4} \overset{*}{\text{---}} 5\tfrac{3}{4} \text{ ... } 6\tfrac{3}{8} \overset{*}{\text{---}} 7\tfrac{3}{8} \quad 8\tfrac{1}{2} \text{ --- } 9\tfrac{1}{2} -$$

The instruments and methods were exhibited and explained by Mr. Sorby and Mr. Browning at the last soirée of the Royal Society, where they excited the greatest interest.

The Rev. Father Secchi has continued his researches on the spectra of several classes of stars. He explains by the differences of temperature, or by the effect of absorption, the variation in intensity of certain lines—the hydrogen line F, for example.

The electric light has recently been fitted up on board the 'Prince Jerome,' the yacht of H.I.H. the Prince Napoleon; and several interesting experiments are to be tried with it. It is not proposed to illuminate the vessel itself, but, on the contrary, to light up other objects, such as a coast or a vessel for the object of attack or defence; ships at full speed or in station can thus be kept free of all danger of collision, and, in action, the object to be hit can be illuminated. The lamp is that known as Duboscq's, which has the advantage of not only having a regular movement when in a vertical position, but also burning with the same precision inclined at any angle, so as to be independent of the pitching or rolling of the vessel at sea. An apparatus is placed behind the lamp, which, hiding the light from the deck of the vessel, projects it in parallel rays on a given spot. Once proved to be useful on board a vessel, the electric light will soon be considered a necessary adjunct to the marine and transport service. The employment of the same light for railways, in the stations and approaches, tunnels, curves, &c., has been actively experimented on in France for some time past.

The question has again been raised of substituting the magneto-electric current for that of the battery in electrotyping, electroplating, and gilding. The magneto-electric machine of Mr. Wilde has been employed in the well-known establishment of Messrs. Elkington, and in Paris M. Christophe and M. Bouillet have resolved to make use of electricity engendered mechanically. They made a first trial at the works of the Alliance Company, and they have ordered two machines of four discs. In the establishment of M. Lenoir, 88, Rue Popincourt, a machine of this kind has been fitted up, which

promises great success. The current is said to be able to deposit a pound of copper per hour.

Mr. Mellor, manager of the Magnesium Metal Company, has been experimenting on the alloys of Thallium and Magnesium, with the object of seeing whether, if such an alloy could be easily made into wire, it might be found to burn readily and to produce an intense bright green flame, when, from the portability of the wire, it would be well adapted to some of the purposes for which a green flame is required. It was found that thallium alloys most readily with magnesium, and in any proportions. The alloys are very stable, and are easily worked up into wire and ribbon. Alloys containing 5, 10, 15, 20, 25, and 50 per cent. of thallium were prepared; these all burn brightly and steadily, but the flame is smaller and the combustion slower than that of pure magnesium. The heat-conducting property of the alloy compared with magnesium is sensibly diminished, showing the change in the molecular construction of the metal. The smoke produced in the combustion of these alloys is more dense, and as it curls gracefully away it is seen to be fringed with a rather pretty dark-purple tint; but the magnesium light is so very intense, that it almost completely masks the thallium flame, so that it is not observable in some of the alloys—indeed, the green light is scarcely recognizable even in an alloy containing 50 per cent. of thallium.

As a concluding paragraph to our Chronicles of Optics we give a very excellent method of cleaning glass, which may be useful where other methods fail. It is taken from the Appendix of the second edition of Major Russell's 'Tannin Progress,' published by Robert Hardwicke, Piccadilly. Dilute the ordinary hydrofluoric acid, sold in gutta-percha bottles, with four or five parts of water; drop it on a cotton rubber (not on the glass), and rub well over; afterwards washing till the acid is removed. The action is the same as that of sulphuric acid when used for cleaning copper; a little of the glass is dissolved off, and a fresh surface exposed. The solution of the acid in water does not leave a dead surface on the glass as the vapour would; if a strong solution is left on long enough to produce a visible depression, the part affected will be quite bright. This method is recommended in some cases for cleaning photographic plates; but we should think it might also be useful in cleaning the insides of bottles, flasks, &c., which have got stained through use.

Heat.—M. Fizeau has been examining the abnormal contraction and dilatation of iodide of silver under the influence of heat. He finds that in this salt, whether in its amorphous or crystalline state, the action of heat is reversed; its dilatation being negative,

contracting instead of expanding on the increase of temperature. But this negative dilatation is not quite the same in the amorphous state, in the state of compressed precipitate, as in the crystalline state. Raised to a temperature of 40° C. the co-efficient is, – 0·00000137 in the first case, – 0·00000139 in the second. This co-efficient is, besides, variable with the temperature and the direction in the interior of the crystal. In the direction in which the contraction is greatest, parallel to the axis, it is the $\frac{1}{1000}$ part for 100°, about a tenth of the dilatation of mercury. To see if this is an exceptional case, he has experimented upon other series of analogous salts such as the chlorides, bromides, and iodides. But he finds that whilst the co-efficient of dilatation of all the chlorides, bromides, and iodides is positive, as it is in the case of other substances experimented upon, as far as he has hitherto found out, the co-efficient of dilatation of the iodide of silver is alone negative.

V. Regnault has determined the specific heat of several specimens of natural and artificial graphite. Graphite from Canada, No. 1, gave a mean number ·19866; from Canada, No. 2, mean ·20198; from Canada, No. 3, mean ·19113; from Siberia, mean ·19879. Graphite from gas retorts, after being heated white hot, gave mean ·1968; the same kind of graphite, after being heated in a current of chlorine, gave ·2000, and that from Canada, No. 3, after like treatment, gave ·1977. Hard burnt clay gave ·1940; therefore the ash in graphite (consisting principally of clay) has no appreciable effect on the results obtained. H. Kopp remarks on the above numbers, that they are obtained by immersing the graphite heated up to 100° in the water of the calorimeter; that graphite is porous; therefore the heat given off by the water as it enters the pores of the substance reappears in the final result of the experiment. Regnault's numbers are higher than those obtained by Kopp.

The behaviour of some minerals at a high temperature has been studied by Dr. Elsner. He has heated a great variety of minerals and other rock constituents in a porcelain furnace to an estimated temperature of 2,500° to 3,000°, and finds in general that silicates containing the alkaline metals, or iron, are much more fusible than those which contain much alumina, or no iron; with the exception of obsidian, all the rocks experimented upon, even those of volcanic origin, presented after heating totally different characteristics from those which accompany them in nature; the crystalline varieties became compact and semi-fused; therefore he says they must have been produced in nature under different conditions from those of his experiments The conversion of pumice into an obsidian-like body is especially interesting. After heating, the rocks experimented on showed lower specific gravities.

Mr. H. Debray has communicated to the French Academy the results of some experiments having for their object to demonstrate that chemical decomposition is analogous to the evaporation of a liquid, in the sense that the tension of the gas proceeding from the decomposition is constant. He operated upon pure carbonate of lime, Iceland spar, or ordinary impure carbonate of lime, placed in the middle of a tube, communicating sometimes with a mercurial pump and sometimes with a gauge apparatus for measuring the tension of the carbonic acid disengaged by the decomposition. The carbonate was alternately submitted to four constant temperatures; *viz.* 360° C. (vapour of mercury), 440° (vapour of sulphur), 660° (vapour of cadmium), 1040° (vapour of zinc). It was found that at 360° the tension of the vapour of the carbonic acid was absolutely *nil;* at 440° it was hardly sensible; at 660° it was only 85 millimetres; at 1040° it attained 551 millimetres.

A remarkable discovery has been made by M. Peligot, from which it would almost seem as if the old tradition of the existence of malleable glass was not quite so absurd after all. A piece of St. Gobain glass, prepared a long time ago by M. Pelouze, had lost its transparency owing to devitrification, but had not altered in density. The piece of glass, supported by one extremity, was placed in a drawer, when it was found, after some days, to have become curved under its own weight, it having become in fact *malleable glass;* the surface at the same time being covered with efflorescence. Pliny speaks in his history of a glass that could be bent and unbent; and the story goes that Richelieu ordered an inventor to be put to death for proposing to divulge a process for making malleable glass.

The following very important conclusions have been arrived at by Messrs. Bussy and Buignet in their memoir on the changes of temperature produced by the mixture of liquids of different natures. 1. In all the cases under examination, with one sole exception, the calorific capacity of the mixture is a little superior to the mean capacity of the elements. 2. The liquids for which the increase of bulk is the most considerable are exactly those which develop most heat at the moment of their union, such as ether and chloroform, alcohol and water, sulphuric acid and water. The only instance hitherto noticed of a diminution of bulk is in the case of the mixture of *chloroform* and *bi-sulphide of carbon*, whilst at the same time decrease of temperature takes place at the moment of the union. 3. Independently of the loss of heat resulting from the changes of volume, there exists a cause which produces an absorption of heat, which can be sometimes equal and even superior to the heat given out by the combination of the liquids. This cause is not quite clearly made out. It is suspected to be related to the phenomenon of diffusion.

The following results have been obtained by M. Becquerel in some researches on the variations of temperature of the ground at different depths, made by the aid of the electric thermometer. At 1 metre beneath the surface of the ground the mean temperature varies between winter and summer as in the air. The difference between the maximum and the minimum is 6° C. in the ground, and 18·17° in the air. At 6 metres deep the variations occur in the inverse order, the maximum taking place in winter, and the difference between the maximum and the minimum being 1°. At 11 metres deep the variation is not more than 0·3°; the maximum takes place in winter, the minimum between the spring and summer. From 16 to 26 metres the variations follow the same law as in the air, with this difference, that the difference between the maximum and the minimum is only 0·27° C. This anomaly or inversion of the law is due to the infiltration of water through permeable strata. Between 26 and 31 metres the variations follow the laws the opposite to those of the air. Below 31 metres the variations of temperature attain scarcely 0·12°, the temperature being sensibly constant.

General Morin has described an electro-thermometric register for marking automatically, every quarter of an hour, the variations of temperature in an enclosed spot or in the open air. Some excellent forms of apparatus have already been invented and put to use for registering the variations of temperature, not only intermittently, but continuously.

A very ingenious as well as commercially valuable form of caloric engine has been lately exhibited in London. In principle it is based upon the fact, long known to scientific engineers, that the most economical mode of obtaining power from heat is by its direct application to the expansion of air, or other permament gases, rather than by that of steam or any other vapour. The hot-air engine now described differs, however, from the usual form of caloric engine in several essential particulars as to its construction, so that it is free from those defects which have hitherto prevented the practical carrying out of the caloric theory. In this engine the motive power, instead of being derived from the expansion of air heated in a separate generator as in former engines, is produced by the expansion of air heated by contact with the fuel itself; and in addition to this source of the power, by the action of the expansive force of the gaseous products of the combustion of the fuel, which heretofore have been permitted to escape into the chimney without being in any way utilized in the production of power. This result is accomplished by placing the fuel in a grate which can be hermetically closed, and forcing into it the air required for combustion by means of an air-pump worked by the engine itself, so that no

part of the heated air or the gases produced by the combustion of the fuel can escape without passing through the cylinder, and there doing duty in the production of force. It is obvious that by such an arrangement the employment of separate iron generators for the purpose of heating the air is dispensed with, and that thereby one of the chief difficulties of the old caloric engine is avoided; for in the hot-air engine the fuel is contained in a fire-clay furnace surrounded by an air-tight iron casing, which in this way is entirely protected from injury. The fuel, which may be anthracite, smokeless coal, or coke, is thus burned under pressure with great regularity and with the production of a uniform temperature, and at a rate exactly proportionate to the duty the engine is called upon to perform, thus avoiding all waste of fuel—a result which has not been attained with any other form of engine yet introduced. The heated air, together with the gases produced by the combustion of the fuel, passes from the fire-box directly into the cylinder, so that every unit of heat produced is converted into force. The piston consists of a hollow plunger, to which the piston-rod is attached; the packing is placed around its upper circumference, where the heat is so moderate as to permit of efficient packing and lubrication. By means of an air-pump worked by the piston, the supply of air is forced into the grate. It here comes in contact with the fire, and a portion of it, in maintaining combustion, combines with the carbon, producing carbonic acid, &c., while another portion of the air in excess takes up heat, and is thereby expanded. The mixed heated air and gaseous products of combustion speedily accumulate such an amount of expansive force as to set the engine in motion, by pressing on the piston. At the end of the stroke the expanded gases escape by the waste-pipe, which may be connected by a stove-pipe with an ordinary chimney. Each upward stroke of the piston produces a downward corresponding stroke of the air-pump, and forces a fresh charge of cold air into the grate to maintain the combustion of the fuel, thus keeping up a continual supply of heated air and gaseous products. The power is increased or diminished by dampers, which pass the air through or over the fire according to the amount required. The chief advantages of the hot-air engine will be found in the very important facts, that there is not the most remote danger in its use; the furnace is perfectly insulated, all risk of fire is entirely avoided, and the presence of water, whether in large or small quantity, is dispensed with; so that this engine can be employed under circumstances where it would be impossible to use a steam-engine.

Father Secchi, a scientific experimentalist who is not usually mistaken in his statements, has lately made the somewhat startling announcement that red-hot iron is transparent. The reverend

Father had ordered a strong iron tube to be made. As it was intended for an apparatus requiring a vacuum, it was essential that this tube should be perfectly air-tight; and as he had some doubts about its soundness in this respect, in order to set these at rest, the tube was made red-hot and taken into a dark place, when there was clearly perceived through the iron (which was half a centimetre thick), a crack inside the tube, and which did not reach to the outer surface. Commenting on this, Dr. Adriani, in the 'Chemical News,' says:—"It is rather curious that the fact of the metal above alluded to, to which I have reason to believe that gold may be added, becoming transparent at red heat, should have escaped the notice of scientific men. It requires, however, a good bright red heat; but the transparency of the metals is evident thus even in daylight, as I know from my own experience while working in an engineering establishment attached to a large sugar refinery now many years ago."

Mr. Stock, another correspondent of the same paper, suggests what we consider to be the more probable explanation. He says that it is more likely that the crack exhibited itself, because where it existed the metal was thinner than throughout the rest of the tube, and would therefore cool more rapidly, becoming in consequence darker coloured, thus showing on the exterior both its extent and direction.

Electricity.—A very important modification of the magneto-electric machine has been suggested by Mr. Tisley, the very able and intelligent assistant to Mr. Ladd, and has been carried out by that instrument maker. It was suggested that if the armature had two wires instead of one, the current of one being sent through a wire surrounding the magnets, their power would be augmented, and a considerable current might be obtained from the other wire available for external work; or there might be two armatures, one to exalt the power of the magnets, and the other made available for blasting or other purposes. This idea has been carried out as follows:—Two bars of soft iron, measuring $7\frac{1}{2}$ in. × $2\frac{1}{2}$ in × $\frac{1}{2}$ in., are each wound round the centre portions with about thirty yards of No. 10 copper wire, and shoes of soft iron so attached at each end that when the bars are placed one above the other, there will be a space left between the opposite shoes in which a Siemens' armature can rotate. On each of the armatures is wound about ten yards of No. 14 copper wire, cotton-covered. If the armature in connection with the electro-magnet is made to rotate, there will be a very feeble current generated in it; this passing round, the electro-magnet will increase its power with every additional impulse. It will thus be seen that the only limit to the power of the machine is the rapidity with

which the armature is made to rotate, which is entirely dependent on the amount of dynamic force employed. The great improvement in this machine is the introduction of the second armature, which, although it takes off currents generated in its wire by the increased magnetism, does not at all interfere with the primary current; and when attached to a regulator is found to give an electric light equal to forty elements of Grove's or Bunsen's at the expenditure of 1-horse power. The machine exhibited by Mr. Ladd at the Royal Society was altogether rudely constructed, and was only intended to illustrate the principle; but with this small machine three inches of platinum wire ·01, could be made incandescent. There is no doubt that this principle is both ingenious and valuable, and Mr. Ladd deserves great credit for the enterprise he has shown in making the machine. But we cannot help asking why does he not in his published papers mention his assistant by name, and so give him the credit which he justly deserves for having made the original suggestion, instead of merely saying that it was "suggested by his assistant." Manufacturers are getting too much into the habit of considering that the credit of merely suggesting improvements is of trifling value in comparison with that of practically carrying them out.

A discussion on the theory of Mr. Grove's gas battery has lately been going on in the French Academy. Mr. Grove supposed that it was indispensable for each of the electrodes of platinum of his gas-couple to be simultaneously in contact with one of the gases, and with the liquid placed underneath. M. Gougoin, agreeing with M. Schönbein, states on the contrary that the action of the platinum does not take place except on the gases already below, and that the gas-receivers should only be considered as reservoirs to maintain the solutions they cover in a state of saturation. The electro-motive force of the gas-couple varies curiously with the state of the platinum wire. Its action is increased, as M. Matteucci remarked, by heating the elements in the flame of a spirit-lamp some instants before employing it. In the most favourable conditions, the electro-motive force of the gas-couple, constructed with platinum wires not platinized, scarcely exceeds 155, taking as unity the electro-motive force of a thermo-electric couple of bismuth and copper, the two solderings of which are maintained at the temperatures of 0° and 100° C. The electro-motive force of the couple of Daniell is represented by 193, and that of the couple of Volta by 178, at the moment of being set to work.

M. Jules Regnauld has examined the modification which mercury causes in the electric position of thallium. Experiments gave the following results. There is elevation of temperature, and thus a disengagement of heat, during the formation of the amalgam

of thallium and mercury. Pure thallium is electro-positive to amalgamated thallium. These experiments prove that the position of thallium is much lower than that which separates cadmium from zinc in the Daniell's couple. They confirm this general proposition —"Every time that a metal is united to mercury, the place which it occupies in the scale of affinities is modified, and thermo-phenomena are observed."

Experiments on the elevation of temperature produced by the galvanic current have led M. E. Edlund to suppose that the current by a special action independent of that of heat, causes an expansion of the conductor which it traverses. He has therefore instituted experiments on that subject, and the result is, that the expansion is perfectly definite. The method adopted is as follows: He takes a metallic wire 1·184 metres in length, the amount of whose expansion by heat is known with perfect exactitude, and passes a current through it. The wire is stretched horizontally between a fixed clip and another working as a lever round a horizontal axis, bearing a mirror, and the measurement of the elongation of the wire is effected by observing the angular displacement of the mirror. If the temperature of the wire at the moment of observation be known, it will be seen whether its elongation accords with this temperature or not. To measure this temperature, M. Edlund measures the electric conductivity of the wire, and deduces the temperature from it. Now by this method he always finds a lower temperature than that which would correspond with the observed elongation, from which it follows that an elongation takes place in the wire independently of the action of heat. The conductivity is measured by the method of Wheatstone's Bridge. The rheostat is composed of two German-silver wires stretched upon a horizontal board. To determine the relation between the temperature and resistance, the wire is rolled round four glass pillars fixed in a wooden disc, and the cylinder formed by the wire placed in a glass vessel containing thermometers, and immersed in a bath the temperature of which was varied. The author gives details of several experiments, and concludes by stating that the current produces in the solid bodies which it traverses an expansion independent of that of heat; and although these investigations are not sufficient to make known the law of this expansion, they show that it increases rapidly with the intensity of the current, and also that this action does not cease immediately on the cessation of the passage of the current through it, but disappears by degrees.

Professor De la Rive has published an elaborate series of experiments on the propagation of electricity in highly rarefied elastic fluids; he finds that the transmission of the electric discharge through rarefied gases is accompanied by a sensible elevation of

temperature; that when the gases are sufficiently rarefied for the discharge to pass readily, and for the light to be stratified, this elevation of temperature is less near the negative electrode than it is near the positive electrode; and that the absolute rise of temperature at the two electrodes, and the differences between them, vary with the density and nature of the gas. A fact which strikingly proves the great calorific and illuminating power of electricity is that hydrogen, under a pressure of only $1\frac{1}{2}$ millim., may be rendered luminous, and become sensibly heated by the passage of electricity, although at this pressure its density is so small that a cubic centim. of the gas weighs scarcely more than $\frac{1}{5000}$ of a milligramme. The gas must in fact have been very considerably heated for it to have been able to raise the temperature of a thermometer, of which the bulb filled with mercury was a cylinder $2\frac{1}{2}$ millims. in diameter and 3 centims. long, 3° in two minutes. The simple fact that the gas becomes luminous is a further proof of its high temperature; for its luminosity is evidently only a result of its incandescence. Professor De la Rive concludes his long and interesting paper by saying that * when one sees that so subtile a substance as hydrogen reduced to 1 or 2 millims. pressure is capable of becoming luminous under the influence of electricity, it is impossible not to be tempted to make a comparison between it and the likewise exceedingly subtile but still luminous matter which composes the nebulæ and cometary bodies. This analogy becomes still more striking when we examine closely the appearance presented, in a tube containing rarefied hydrogen traversed by the electric discharge, by the kind of mist which shows itself when a small quantity of gas is caused to enter the tube, and which likewise appears in the dark space when a certain degree of rarefaction has been passed. The gaseous matter is there even more highly rarefied than it is at the other parts of the mass, thus making its resemblance to the luminous matter forming the comets and nebulæ still more decided. We may add that recent researches on the part of various astronomers have shown that the rays yielded by the prismatic analyses of the light of these celestial bodies are exactly similar to those given by the electric discharge, when transmitted through rarefied nitrogen, and especially through hydrogen. Do these gases, then, which intervene in most of the phenomena of terrestrial physics, play an equally or even more important part in the phenomena of cosmical physics? There is nothing improbable in this conjecture, especially since the analysis of aërolites has shown that planetary space does not contain any element not found also upon our globe.

A curious experiment on the transportation of substances by the voltaic and induction current has been published by M. Lewis

* 'Phil. Mag.,' xxxiii. 260.

Daniel, Professor of Physics at the Central School of Arts. It is generally admitted that the current of the pile moves in the interpolar circuit from the positive to the negative pole. The existence of a mechanical action exerted in this direction is confirmed by the movement produced in the carbon by the voltaic arc. It is evident also from the difference of level which takes place under the influence of a current, in a vessel divided into two compartments by a porous diaphragm, and enclosing a liquid of weak conductivity, which at the commencement of the experiment presents two surfaces of equal height at each side of the separation. The movement of the liquid, by the current discovered by Porret, has been examined by Messrs. De la Rive, Becquerel, and latterly by Windemann, who has determined its laws under certain conditions. It is possible to place in evidence this action of electricity, and to show the direction by an experiment more simple than the preceding. M. Daniel fills, with slightly acidulated water, a glass tube of any length, and of a diameter from ten to fifteen millimetres, bent at a right angle at its two extremities. He introduces into the liquid column a globule of mercury two or three centimetres long, and immerses the electrodes of a more or less powerful pile into the two vertical portions. By means of the globule of mercury the instrument is easily levelled. As soon as the current passes the globule becomes elongated and begins to move; going from the positive to the negative pole. If by means of a commutator interposed in the circuit, the direction of the current be changed, the globule stops and immediately takes an opposite direction, always from the positive to the negative pole. By properly moving the commutator, we can make the mercury take an indefinite alternating motion. The ends of the globule under the influence of the current do not present the same appearance. It is brilliant towards the negative electrode, and dull towards the positive one. This is owing to its possessing positive tension in front and negative tension behind. The oxide of mercury formed during the experiment is collected at the negative end, and is reduced, at least in part, by the hydrogen produced at the same time. If the liquid contain too much acid, a salt is formed which affects the transparency of the liquid, and bubbles of hydrogen are disengaged.

When the direction of the current is altered, a sort of veil which covers one of the extremities of the globule is seen to fly to the other extremity. Four Bunsen elements suffice for this experiment, if we employ a tube 0·40 m. to 0·50 m. long. With twenty-four elements we can operate upon a tube a metre long. The current of fifty elements gives too great a velocity to the mercury, and breaks it up into globules which travel in the same direction. When the tube is inclined the mercury can still move from the lower to the upper end. Thus the weight of the mercury being

known, we can form a very clear idea of the work performed by the portion of the current which traverses the globule. If the inclination be progressively augmented, a moment arrives at which equilibrium is established between the force of the current which tends to make the mercury ascend and the action of the weight which causes it to descend, the globule resting stationary, but elongated. It is subject to a very apparent interior movement, and takes a rotatory motion, first in one direction, then in another. The same experiment can be made by means of a Ruhmkorff's coil. As the currents furnished by this apparatus are alternately in contrary directions, a commutator is necessary to suppress the inverse current. It is important to remark that the conductivity of the transported material is one of the necessary conditions of the movement; a globule of bisulphide of carbon introduced into the tube is insensible to the passage of the current. These experiments have a close similarity with those which Mr. Gore, F.R.S., described before the Royal Society some years ago.

The Abbé Moigno has brought forward a claim to be the first to make known the nature and application of the mysterious agent, ozone. In 1845, on the first news of the curious observations of M. Schönbein, he says he proceeded to Basle and visited this celebrated chemist. The abbé then wrote to the 'Epoque' a letter, inserted on December 31, in which the following very important passage occurs:—"It is necessary to return immediately to the ideas of Ampère, and consider the atoms of bodies as having two states—first, with the essential primitive electricity or in a nascent state; second, with their electricity more or less disseminated, or their atmosphere of electricity in a neutral state. The ozone of M. Schönbein is, in our eyes, only a molecule of oxygen in a nascent state, with only negative electricity in its atmosphere. I am, I think, able to rigorously prove and account for the wonderful properties of this agent that we cannot lay hold of, and of which so much has been said." The abbé says that he asks all chemists of that time, and Dr. Thomas Andrews, of Belfast, in particular, whether at that period any one had so clearly defined the essential nature of ozone: so much talked about, written upon, and discussed without any decided conclusion being arrived at. Two years afterwards the same reverend author asserted in the 'Nouvelle Revue Encyclopédique' of M. Didot, for July, 1847, the following more explicit statement:—"Sufficient attention has not been yet paid to the important fact that oxygen disengaged by plants is not in a neutral state. We are perfectly convinced that this nascent oxygen, without its positive atmosphere, is the ozone discovered by M. Schönbein, with an odour *sui generis*, and possessing, in the highest degree, all the properties of electro-negative substances. The bleaching of linen stuffs, ivory, wax, &c., in the open air, on

grass, the formation of nitric acid and saltpetre, also many other phenomena, are only caused by the powerful action of oxygen in a nascent state, or with its negative electricity developed."

From 1845 to 1867 thousands of contradictory opinions have been written on the subject of ozone, but men of science are now returning to the idea clearly pointed out above. The Abbé Moigno has so often pleaded the cause and defended the interests of English scientific men, that we consider it a duty to lend our influence to establish his claim to this forecast of a great discovery.

11. ZOOLOGY (ANIMAL MORPHOLOGY AND PHYSIOLOGY).

(Including the Proceedings of the Zoological Society.)

Morphology.

A new Gland in the Human Body.—Von Luschka of Tübingen drew the attention of Human anatomists lately to the presence of an undescribed gland situated at the terminal extremity of the human backbone, which he called the Coccygeal gland, comparing it with the pineal gland. Krause has since found the same body more largely developed in *Macacus cynomolgus*—and Meyer has examined the tails of the dog, rat, and mouse for a similar structure, but without success. In the cat, however, a similar structure was found. Meyer is inclined to regard this very remarkable body as similar to the caudal hearts or retia mirabilia, which are appendages of the arterial system in many animals.

Cervical Ribs in Man.—A case of a woman is recorded by Dr. Stieda of Dorpat, in which a pair of cervical ribs sprang from the seventh cervical vertebra. The ribs appear to have been well-marked fully formed pleurapophyses, and were attached by cartilage below to the sternum. The other vertebræ in the body were normal.

Professor Humphry on the Chimpanzee.—Two specimens of the *Troglodytes niger* have been dissected lately by the Professor of Anatomy at Cambridge, and he gives some account of his observations in the 'Journal of Anatomy and Physiology,' the second number of which has just been published. Professor Humphry makes some excellent remarks on the joints of the limbs, and points out the way in which structure is here concurrent with habit. He dwells on the differences between man and the ape, and discusses the use of the word Quadrumanous. If we are to regard that extremity of a limb which is adapted for grasping as a hand, then assuredly the ape's hind-limb-extremity is as much a hand as

man's fore-limb-extremity; each differing in an exactly comparable manner from the feet (fore and hind) of the bear or dog. If, however, man's hand is to be the anatomical standard of comparison, Professor Humphry admits that there is a wide structural difference between the ape's foot and a hand. He seems inclined to favour the adoption of the term Chiropoda as a substitute for Quadrumana, a term which comes to us from Professor Halford in Australia, who has taken up this question as a strong Owenite, and has written a pamphlet on the monkey's foot.

Dentition of Marsupials.—Mr. Flower, the Conservator of the Museum of the Royal College of Surgeons, has quite recently communicated an interesting discovery to the Royal Society relative to the teeth of the Marsupial Mammalia. The lower forms of Monodelphous Mammals (*e.g. Bruta*) differ in their dentition from the higher, in having, as a rule, but one set of teeth, which lasts them for life, whilst the higher forms have a temporary set of teeth when quite young, whose place is afterwards taken by the permanent teeth—incisors, canines, and "premolars." From the examination of the jaws of adult marsupials, it appeared highly probable that they, although so low in the scale of mammalian life, resembled the higher members of the class in having a large milk or temporary dentition. Mr. Flower has succeeded in showing that this resemblance, like many others exhibited by the marsupials in relation to monodelphous mammals, is merely superficial. No marsupial, Mr. Flower finds, has ever more than four temporary teeth, and apparently all agree in having these four—one in the molar series of each half of each jaw. This tooth is succeeded by what is to be regarded as a premolar, and is chiefly remarkable for this, that it corresponds to that premolar (*viz.* the most posterior) in man and all the higher mammals, whose milk-predecessor is the first to develop, which appears earliest itself, and which in the various modifications of the dental series in the Mammalian class is the largest and most constant.

Sowerby's Whale.—The *Ziphius Sowerbiensis*, a rare whale of which there are only two or three specimens in the museums of Europe, is chiefly interesting as being one of the few living representatives of a very considerable group of dolphins, with long, firm, cylindrical snouts, called Rhynchoceti by Eschricht, and having teeth only in the lower jaw, and there but two or four of large size, almost like tusks. One of the known specimens of Sowerby's whale was cast ashore sixty years since in Elginshire, and its skull is now at Oxford. Another male specimen has lately been cast ashore on the coast of Kerry, and the head and teeth were procured in a perfect condition by Mr. Andrews, of the Royal Dublin Society. At a recent meeting of the Microscopical Society of London, Mr. Ray Lankester read a paper on the teeth of the Oxford specimen, in

which he showed that they presented a very low type of structure (resembling fœtal teeth), corresponding to the degradation of their function from prehension or mastication to mere incidental "sexual marks." The structure of the recent teeth also threw some light on the nature and condition of fossil cetacean teeth in the Red Crag, called *Balaenodon* by Professor Owen.

Dentition of the Mole.—The teeth of the common mole have also recently received attention from Mr. Spence Bate, who is well known for his writings on teeth as well as for his more numerous observations on Crustacea. The dental formulæ in Insectivorous mammals is often a matter of extreme doubtfulness, and is one which can only be properly settled by the study of their development. Fred. Cuvier, Bell, De Blainville, Owen, and Blasius have each assigned a different dental formula to the mole. Mr. Bate has examined the jaws of young moles from the period when they have no hair on the body, and has satisfactorily shown what is the origin and what the antecedents of the permanent teeth. He considers that his observations confirm the formula given by Owen, *viz.*:—

$$i\,\tfrac{3}{3}\ c\,\tfrac{1}{1}\ pm\,\tfrac{4}{4}\ m\,\tfrac{3}{3} \times 2 = 44.$$

Mr. Bate's paper was communicated to the Odontological Society, and is published in abstract with a plate in the 'Annals' for June.

Ray Society.—'Nitzsch's Pterylography' is the title of the last volume issued by the Ray Society, having been translated by Mr. W. S. Dallas from the German. Pterylography is the study of the distribution of feathers, and their arrangement in "feather tracts," or "pterylæ," on the bodies of birds. Nitzsch was one of the most single-minded and persevering naturalists of his time—he devoted nearly the whole of his life to accumulating material for the present work, and one or two other matters relating to birds, to which class he entirely gave himself up. He died, however, before he could make up his mind to bring together his results. His friend, H. Burmeister, who succeeded him at the University of Halle, made it his first duty to do what he could with Nitzsch's material; and the German edition of 1840 was the result. The present translation is admirably performed, and the ten original plates of small folio size are well rendered. Before Nitzsch wrote, no one had made a philosophical attempt to discriminate the dermal appendages of any of the Vertebrata, beyond the rough division into Scales, Hairs, Bristles, and Feathers. He, however, has shown in a most masterly way, that there are definite regions marked out on the bodies of birds, which carry different sorts of feathers, and that these regions or pterylæ (feather-forests) can be compared and identified in different genera and species of birds, and that they furnish a means of classifying birds in a very natural way, limiting groups which are otherwise doubtful, and exhibiting their value and importance in other ways.

Pterylography is not a subject which has been much taken up in England; indeed the papers by Dr. Sclater and Mr. Bartlet appended to this volume are amongst the only contributions to its development in this country; hence Mr. Dallas's translation will be found acceptable by all scientific ornithologists, and ought to bear good fruit.

The Glass-rope.—The veteran zoologist Ehrenberg has communicated a paper on this much-discussed organism to the Berlin Academy. He, it appears, formerly considered the Hyalonema to be simply an artificial product of Japanese industry. He now abandons that notion, and gives his reasons for regarding it as a Sponge. At the same time he urges in a most curious way the vegetable nature of sponges, and regards the long hair-like spicules of the glass-rope as tending to confirm his view of the vegetable nature of sponges in general. He adduces the fact of the inhalent orifices of sponges being permanently open, as evidence against their animal nature, for no animals have a permanently open mouth; thus he attributes to zoologists who do not agree with him the view that a sponge is not a complex mass of units, but rather a few individuals conjoined whose mouths and anal apertures are respectively represented by the inhalent and exhalent orifices. Good evidence appears to have been brought forward in favour of the existence of a European species of Hyalonema; but this part of the question is certainly not yet definitely settled.

Excavating Sponges.—Mr. Albany Hancock, who in 1849 published a paper on these curious perforating organisms, has lately returned to the subject. He fully admits that at present the question as to the manner in which they excavate shells is not solved, their power being obtained perhaps by means of their spicula or by some other method. Dr. Bowerbank, in his Monograph of the British Spongiadæ, maintains that the minute galleries in the shells in which these sponges occur are excavated by "lithodomous Annelids." Mr. Hancock remarks that if this is so, we ought to find the annelid there, which we do not; only one annelid is recognized as perforating limestone, in the manner which Mr. Hancock attributes to *Cliona*, and that is a species of *Leucodore*. Mr. Hancock shows also very clearly that the dendritic and irregular character of the *Cliona* borings differs from anything similar done by worms. He describes four new species, characterized by the form of their spicula. They occur in the shell of a species of *Chama;* in the shell of a *Purpura*, from Mazatlan; in the shell of *Spondylus gœderopus*, from the Mediterranean; and in the shell of a *Serpula*, adhering to a *Chama* from Mazatlan.

Physiology.

The Blood and Work.—According to Hoppe-Seyler, the constituents of the tissues are oxidized *outside* the blood-vessels, and not after they have found their way into the blood, as maintained by Estor and Saintpierre. Hirschman opposes also the view that carbonic acid is formed *in* the blood at all. He maintains that it is formed in the tissues, and passes thence into the blood. Mr. C. W. Heaton, of Charing Cross Hospital, comes forward in the 'Philosophical Magazine' to maintain the view that oxidation takes place in the blood. His opinions will be found in his article on this subject in the present Number.

Regulation of the Heat of the Body.—Van der Hoeven was one of the first to point out the inaccuracy of the common division of animals into "warm" and "cold" blooded—the true expression of the difference not being contained in the words. What we call *cold*-blooded animals are those animals which have but little independent temperature, but vary almost equally with the medium which surrounds them. Warm-blooded animals, on the other hand, are such as have the power of *both* lowering and raising their own temperatures relative to that of the circumambient fluid. MM. Jacobson and Landré, of Utrecht, have recently made some observations on this power of self-regulation. Bergmann and Donders recognized in the skin the moderator of animal heat, and found that in its vaso-motor nerves the self-regulation takes place. In different animals particular parts of the skin are specialized as moderators. In the dog, the paws, nose, and tongue; in the ape, parts of the face; in cocks and turkeys, the vascular combs and gills, which usually have a low temperature, but under particular circumstances become very warm. The ears of the rabbit are perhaps the most remarkable of any of these organs, since they are provided with means of an alternate contraction and dilatation of the blood-vessels. MM. Jacobson and Landré have experimented successfully on the rabbit, and have fully shown that the ears have this important function; and further, that its exercise is entirely dependent on the sympathetic system of nerves.

The Croonian Lecture for 1867.—Dr. J. B. Sanderson's purpose in the Croonian lecture, delivered before the Royal Society, "On the Influence exerted by the Movements of Respiration on the Circulation of the Blood," was to show the incorrectness of the statement frequently made, that the frequency of the pulse is lowered and arterial tension diminished during inspiration. He shows, on the contrary, by experiments made upon dogs, that the immediate effect of inspiration as well as of exspiration, in natural breathing, is to increase both the force and frequency of the heart's action; and even when the trachea was plugged and stopped, the efforts

at inspiration caused increase in the force and frequency of the pulse. This effect of inspiration is entirely mechanical, and is due merely to the expansion of the chest aiding the diastole of the heart, for it has been found, *cæteris paribus*, that whatever tends to assist the diastoic movement increases the force and frequency of the contractions of the heart.

Miscellaneous.

Recent Publications.—Mr. Andrew Murray, F.L.S., has given to the world a most sumptuous volume on the Geographical Distribution of Mammals. It contains some most excellent and elaborate maps, is printed most charmingly, and is published by Day and Co. It is, however, only to be regarded as a compilation, and we regret to say that even as such is deficient with regard to two or three cases in which we happened to test it. Mr. Murray's original views enunciated in certain parts of the book cannot carry much weight; at the same time, the book is a pleasing contribution to zoological literature.

The last Part issued of the Philosophical Transactions of the Royal Society contains Mr. Charlton Bastian's very elaborate researches on the Nematodes, illustrated by many plates. It also contains the first part of Dr. Carpenter's memoir on *Autedon* (*Comatula*) *rosaceus*. This memoir is, indeed, such a one as might be looked for from its talented and learned author. After spending the earlier part of his life in the preparation of those valuable books which are so well known, Dr. Carpenter now intends to devote himself (as he says in the preface to the last edition of his Human Physiology) to original observation. This beautifully illustrated and elaborated memoir is an indication of what we may look for.

Obituary.—It is with true sorrow that we record the death during the past quarter of one of the most eminent and laborious of British anatomists—John Goodsir, Professor of Anatomy in the University of Edinburgh. Together with his brother Harry (who perished in the Franklin expedition) and Edward Forbes, he wrote many valuable zoological papers, and became a Fellow of the Royal Society of London in 1846, after communicating through Professor Owen his well-known paper on the supra-renal, thymus, and thyroid bodies. About the same time he was elected to the Edinburgh chair of anatomy. The lectures which he there gave are among the most remarkable productions of their kind, containing no mere digest of manuals and text-books, but forming rather the means by which he communicated to the world his own original philosophical views and important observations on the matters which he discussed. For many years he suffered from paralysis of

the lower extremities, which at last ended in his death. He was in his fifty-fourth year. Dr. Wm. Turner, who was for many years demonstrator and assistant-professor, has been elected to the Professorship, and has already given hopes, by his anatomical and literary labours, of being no unworthy successor to his great master.

Proceedings of the Zoological Society.

The papers read at this Society during the past quarter have been as varied and interesting as usual.

Relating to Mammalia, Mr. Thomson sent a communication on a deformity of the lower jaw of the sperm whale (*Physeter macrocephalus*), and Dr. Macalister has given some details on the anatomy of a cetacean (*Globiocephalus*) recently stranded on the coast of Ireland.

Mr. St. George Mivart, who is making himself a good name as an osteologist (*vide* his paper on the "Osteology of the Insectivora," in the 'Journal of Anatomy and Physiology,') has read a paper "On the Structure of the Skull of the *Propithecus diadema* of Bennett;" and Dr. J. E. Gray has furnished an important essay on the skulls of the Felidæ, in which he has carefully pointed out the variations which occur in this part of the structure of the different members of this group of animals. Professor Allman, who recently described to the Society the details of structure of the *Potamogale velox* of M. P. B. du Chaillu, in which he showed that it was an Insectivor, and defended M. du Chaillu's claim to its discovery, has communicated some further supplementary observations on this highly interesting animal.

Relating to Birds, we have some papers of more than usual value. Professor Huxley, who has been working at this class in connection with his Hunterian lectures, has put forward quite a new classification of these animals based upon their cranial structures. The classification is mainly founded upon the characters presented by the bones of the palate. It was proposed to divide the class Aves primarily into three divisions:—1st, the Saururæ, containing only the fossil *Archæopteryx;* 2nd, the Ratitæ, containing the struthious birds; 3rd, the Carinatæ, containing all the other birds. The Carinatæ were subdivided into four great groups, distinguishable by cranial characters, and denominated Dromeognathæ, Schizognathæ, Desmognathæ, and Œgithognathæ. These contained altogether sixteen alliances, which were further divisible into families. Dr. J. E. Gray, who was in the chair when this paper was read, remarked at its conclusion that he considered internal characters as of but very little use in classifying

animals. Dr. J. Murie, the Society's Prosector, has made some observations on the Tracheal Pouch of the Emeu (*Dromœus Novæ Hollandiæ*). He discussed the structure of this remarkable organ and of the opening of the trachea into it, and made some suggestions of its probable use in the bird's economy. The birds added to the Society's menagerie have been from time to time noted by the Secretary. Amongst others the various species of gulls, and especially an example of *Larus fuscescens* (Licht), from Mogador, were remarked upon. Mr. Gould has described a new bird from the interior of South Australia, which he proposes to call *Malurus callainus;* and other short ornithological papers have been laid before the Society. No Reptiles appear to have engaged the Society's attention during the quarter, but we have a few papers on Fishes. Amongst these are those of Dr. F. Day, "On the Fishes of the Neilgherry Hills and Rivers," and two by the same author "On Fishes from Western India."

New Mollusca from China have been described by Dr. Baird and Mr. H. Adams, amongst which were some interesting forms of Unionidæ collected at Shanghai by Dr. J. Lamprey.

The Coleoptera of the Azores have formed the subject of a communication from Mr. G. R. Crotch, in which he has given an account of a very fine collection of these insects formed by Mr. F. Godman during a recent visit to those islands.

The interest in the beautiful Lace-sponge has been augmented by a communication from Dr. Bowerbank on *Euplectella speciosum* (Owen), in which he gave a detailed account of the structure of this organism. Dr. J. E. Gray has brought before the Society some new genera of Sponges, and at the same time gave some notes upon a new classification of the class.

THE PUBLIC HEALTH.

LONDON.—The principal feature in the Sanitary Legislation of the quarter has been the introduction of a new Vaccination Bill. The necessity of further legislation on the subject of vaccination has been felt by the alarming fatality of the present epidemic of smallpox, which has been very fatal in London, and has extensively prevailed in the provinces. This epidemic is still continuing, and existing legislation has been found quite unable to ensure the vaccination of the community. So prevalent has been the smallpox, that some persons have asked the question as to whether the cowpox is so perfect a preventive of smallpox as we have been led to consider it. With regard to this question, it may be asserted with the utmost confidence that where the disease of cowpox has been properly communicated to an individual, in such cases there is no more tendency for such an individual to take smallpox than if he had had smallpox itself. There is in a very small number of cases a tendency amongst persons who have had smallpox to take it again. It is, however, very questionable as to whether this number is at any time sufficient to keep up the smallpox in a community. We have also abundant evidence to show that in communities where the practice of vaccination is carefully carried out, there smallpox is only an exceptional visitor.

When the practice of vaccination was first introduced by Jenner in this country, the demonstration of its being able to prevent smallpox was so complete that it was never contemplated that there would be any persons who would neglect for themselves or their families so important a means of preventing a foul and fatal disease. Every adult in the country had more or less personal experience of the fatal nature of smallpox, of the loathsome character of its symptoms, and the deformities it inflicted on those who had had it. But gradually these recollections passed away, and there sprang up in the community persons belonging to the party of medical impostors who maintained that cowpox did more harm than smallpox, and thus an indifference to vaccination has been engendered. It was then sought by legislation to remedy the consequences of this indifference, and powers were given to the Boards of Guardians to superintend the vaccination of their districts. Up to the present time this legislation has failed to secure the object desired, and a new Bill is now passing through the House of Commons for the purpose of improving the old Acts. Without going into the details of either the old or new Bills, we would observe that in all there is the same fatal oversight which must render impotent all attempts at vacci-

nation legislation. In England and Wales we have no compulsory registration of Births, and consequently there are no existing means of ascertaining whether every child born is vaccinated. In some districts in London it is believed that 25 per cent. of the children born are not registered. Yet in spite of this, the legislation assumes in its Vaccination Bills that every child born can be easily discovered for the purposes of vaccination. The necessity of compulsory registration in England and Wales has been pressed upon our Home Secretaries, on Poor Law Secretaries, on Presidents and Vice-Presidents of Privy Council for years, and not the slightest effort has been made in Parliament to secure a return of births, upon which alone can be founded any accurate statistics of the relations of birth to death in the kingdom.

Another reason of the failure of our Vaccination Acts has been the small sum given to public vaccinators for performing the operation of vaccination. The former Acts named 1*s.*, and the present Bill offers 1*s.* 6*d.* Now our legislature ought to know that this is no payment for professional service, and that an operation requiring skill and attention will never be properly performed for such a payment. The operation thus paid for is entrusted by medical men to their apprentices and assistants, no satisfactory evidence of the operation being properly performed is ever given, and thousands annually undergo a sham operation, and are let loose on society to take and propagate the smallpox. It is a well-known fact that in parishes where higher fees have been given to the public vaccinator than the minimum allowed by the Act, that there smallpox has not been known. Give the medical man an interest in looking after the cases of unvaccinated children and he will do so, and there will be no need for an elaborate system of certificates or inspectors. The fact is, if enough is paid to make it the interest of a respectable medical man to see after unvaccinated children, and also to ascertain that the vaccination has been properly performed, there hardly needs any further legislation.

In a paper on Vaccination, recently published by Mr. Rumsey, of Cheltenham, whose opinions on State Medicine are always entitled to respect, he states his conviction that no compulsory Vaccination Act will ever succeed in this country. He advocates indirect compulsion by refusing admission into schools, factories, and all kinds of service, unless proof should be given of successful vaccination. He also advocates the removal of the superintendence of vaccination from the hands of the Poor Law authorities, and the placing it in the department of the Medical Officers of Health who are appointed by the vestries.

Amongst the sanitary subjects demanding the attention of the legislation, is that of sea-scurvy. There is no doubt an increased tendency to the development of this disease on board our mercantile

marine. The prevention of sea-scurvy is as simple as that of small-pox, but neither masters nor men will voluntarily adopt it on board our ships. We have a law compelling ships to take out lemon-juice, that it may be served to men on voyages beyond a certain duration. But if the sailors will not inform there is no one to prosecute. There ought to be a much more vigilant superintendence of ships going long voyages. At any rate the law might compel captains to take out lemon-juice, and when ships arrive with scurvy on board, an investigation as to its cause should immediately take place. The duty of superintendence should be placed in the hands of the Medical Officer of Health, when there is one in the port from which the vessels sail, or a special Medical Officer of Health should be appointed for this duty.

Up to the present time no alarming outbreak of cholera in large populations has been reported this year, either in this country or on the continent of Europe. We may hope, therefore, that for the fourth time in the present century this plague has retired. It would be well if we could hope that the lessons taught by the last outbreak would be sufficiently impressive to render any further outbreak impossible. We have learned some new facts in the last outbreak—we have had old impressions confirmed, and some old prejudices removed. There is no doubt now that the cholera is brought here from the East, and that it travels by means of human intercourse. The cholera epidemic of 1866 has shown more clearly than ever that this disease is dependent on a special poison, and that this poison is capable of being conveyed more particularly by the agency of water. The several outbreaks of the cholera in the towns of the continent showed that in all probability the water supply of these towns had become contaminated, whilst the outbreak of the cholera in London, confined almost entirely to one district, and that district having an impure supply of water, confirmed the suspicion which had been created by the history of the outbreaks of cholera in 1848 and 1854, that the drinking-water of the metropolis was the principal means by which the poison of the disease was propagated.

An interesting meeting for the purpose of deliberating on some questions connected with cholera, took place at Weimar on the 28th and 29th of April last. This meeting consisted chiefly of German physicians, of whom the most distinguished were Professors Pettenkofer and Griesinger. Mr. John Simon attended from England. There were about sixty physicians present. The questions proposed for discussion were as follows:—

1. The causes of the spread of cholera.
2. The advisability of using disinfectants.
3. The nature of disinfectants.
4. Points for further investigation.

With regard to the first question, the conference was unanimously of opinion that cholera is spread by means of a poison. Of the nature of the poison, there was not sufficient evidence to arrive at any definite conclusion. Dr. Klob, of Vienna, and Dr. Thomé, of Cologne, both exhibited specimens of low organisms that they had discovered in the dejections of cholera patients. These forms were cellular, and produced by germination fungoid growths similar to those found in moulds. The Conference received with much caution these communications. It will be remembered that in this country in 1848, Drs. Britton and Swayne, of Bristol, discovered germs of a similar nature in cholera investigations. There was every reason to believe that the organisms then found were not peculiar to cholera, but that they were organic bodies of various kinds that had probably been taken into the intestines by food. Too much caution cannot be exercised in coming to conclusions with regard to the significance of these so-called cholera-spores. With regard to the propagation of cholera by drinking-water, Mr. Simon brought before the Conference the experience of London in the three last epidemics. The demonstration of water conveying the poison has not been apparently so complete anywhere as in London. Professor Pettenkofer laid his researches upon the influence of soil on the production of cholera before the Conference. He maintains that soil overflowing with sewage, and suddenly becoming exposed from the sinking of the ground-water, is a *nidus* for the spread of cholera-poison. This subject was one which the Conference agreed required further investigation before any fixed laws could be laid. On the second point, the utility of disinfection, the Conference was quite agreed. Where disinfectants had not succeeded, the causes were clearly pointed out, as in the movements of troops, thoroughly bad buildings, and overloaded drains and cesspools, or the use of impure drinking water. The disinfectants especially recommended by the Conference were carbolic acid and sulphate of iron. The latter disinfectant has not been much used in England, but it has one qualification that has led to its being recommended by Professor Pettenkofer, and that is its permanency and acid reaction. Other disinfectants, as chlorine, carbolic acid, and the permanganates, act well immediately, but lose their power in the course of a little time. The Conference recommend a mixture of carbolic acid and sulphate of iron for ordinary disinfection. For soiled linen it was recommended that it should be boiled, and then dipped in a solution of sulphate of zinc. This should be constantly used for water-closets, drains, cesspools, and accumulations of vegetable and animal matter.

The Conference recommended that attention should be given to the following points:—1. To lower organisms in reference to cholera. 2. To the influence of drinking-water. 3. The con-

dition of the soil and the influence of the height of ground-water. 4. Whether cholera be transmitted through goods. 5. The relation of cholera to other diseases coming after. 6. The spread of cholera on board ship.

We may add to these notes on cholera that a Commission appointed to inquire into the supply of water for the East London Water-works have reported and confirmed the worst suspicions with regard to the impure nature of the supply of water to the people of the East of London in July last. Captain Tyler also, in a report made to the Board of Revenue, has confirmed all these statements of the impurity of the East London water-supply. Whilst refraining from giving an opinion as to whether this water contained the poison which killed the people in the East of London, he gives a fearful picture of the wretchedness of many districts that he visited. He clearly shows that during last summer large numbers of families had a deficient supply of water, and gives pictures of the dirt and misery of people for want of water that ought not to exist in a country where there is a legislation professing to care for the poor on the one hand, and a water company with plenty of water to supply on the other. It is painful to contemplate the unworthy reasons that are assigned by people in power for not exercising the slightest authority in removing from their poorer neighbours the cause of disease and death.

In our last number we mentioned that a deputation of the Social Science Association was about to wait on the President of the Privy Council for the purpose of urging upon him the necessity of an amendment and consolidation of the laws relating to public health. The Duke of Marlborough and Lord Robert Grosvenor, the President and Vice-President of the Privy Council, with whom was Mr. John Simon, received the deputation on the 2nd of April. Their Lordships were addressed by Mr. Rendle, Dr. Lankester, Mr. Rumsey, Mr. James Beal, and Dr. A. P. Stewart. The point chiefly urged by the speakers, was the want of anything like unity in our sanitary legislations.

Mr. Rumsey, so well known for his work on State Medicine, urged the necessity for the union and consolidation of central authority in sanitary matters, which is at present distributed between the Privy Council, the Home Office, the Poor Law Board, and the Registrar-General, producing uncertainty and confusion in local administration. He also pointed out the great anomalies which mark local administration in the provinces, the variety of boards existing under poor-law and local government and Public Health Acts; and the remarkable difference in the area and population of the districts under these several boards, the inhabitants of a district varying from less than a hundred to many thousands. He recommended an improved constitution of local boards with higher qualifications for

their members and the extension of areas of local government, so as to provide for an economical and efficient administration of the health laws. He showed how this extension of area affected the appointment of health officers, and urged the necessity for an entirely different system of those appointments which in the provinces were made under the Public Health Acts. He instanced the inspection of factories and work places, especially the extension of the Factory Acts now before the House of Commons as a reason for appointing a highly qualified class of officers rendered independent of private practice and debarred from it. He noticed the importance of such independence as regards certificates of health, age, and fitness for labour of the children employed. He also mentioned Mr. Torrens's Bill for dwellings for the labouring classes as requiring the action of a health officer, who ought certainly to be independent of the proprietors and householders of the wretched hovels he might have to condemn. The basis of an improved organization, he considered, was to be found in the registration divisions of the country which are identical with the poor-law unions. It is in these districts that the great facts of disease and mortality are recorded; in these, therefore, a scientific officer is especially needed, both to correct and verify those returns, and to apply them to the suggestion of practical remedies. It would be a most false step in sanitary legislation to compel every small local board to appoint its own officer of health on its own terms. He warned the Government against enforcing, or even encouraging the present defective system of these appointments, and urged the importance of making a new organization of scientific persons the foundation of a truer sanitary reform.

Dr. A. P. Stewart drew attention to the want of Health Officers throughout the country. In London alone was the appointment of officers of health imperative, and he showed that the size and population of their districts varied enormously, as also their salaries, one having as little as twelve guineas, another as much as 1,000*l.* a year. Only in nineteen out of fifty-nine large districts were health officers appointed, and the average of inspection was in London one to 34,000, and in provincial towns one to 42,000, of a population, rendering impossible any effectual inspection or removal of nuisances. And, as if to complicate matters still more and to prevent any hearty co-operation in carrying out sanitary improvements, the inspectors of nuisances were in not a few instances independent of the officer of health, under whose control they should always be placed.

These remarks afford a lesson, and hit a blot in our sanitary legislation. The Metropolitan Management Act made it compulsory on the vestries to appoint medical officers of health. The consequence has been that London has got its medical officers of health, and in districts where the vestries are not wholly abandoned to the

worship of dirt, a great deal of good has been effected. But the drawback—the blot in this otherwise excellent arrangement—is that the Act gives the vestry the power to elect these officers, and to name their salaries. The consequence is, that in one instance a vestry has had the insolence to offer its medical officer of health, the magnificent stipend of twelve guineas a year. Not one single vestry in London can be said to have behaved honourably and trustworthily in this matter. Saint Pancras, after having appointed an efficient officer of health, and given him 400*l.* a year for two years, deliberately reduced it to 250*l.* a year, without diminishing the duties of the office. Saint Marylebone, on the death of Dr. R. D. Thomson, handed over the office to his successor on the condition that he accepted it for 300*l.* a year. Paddington has just reduced the salary of its health officer from 300*l.* a year to 250*l.* Saint James, Westminster, the richest parish in London, reduced the salary of its health officer four years ago from 200*l.* to 150*l.* a year.

During the past quarter, two interesting discussions have taken place in the Health Department of the Social Science Association. The first was on the Fourth Annual Report of the Coroner for Central Middlesex. On the reading of the paper on the 13th February, there was a general discussion, and the following points were reserved for an adjourned meeting:—1, the propriety of appointing special experts to conduct post-mortem examinations at coroners' inquests; 2, the advisability of introducing the inquiries of the Coroner's Court in every case of death in workhouses; 3, the necessity of erecting public mortuaries in the metropolis otherwise than in connection with workhouses.

Dr. W. Farr was in the chair, and the following resolutions were carried:—

"That this meeting is of opinion that it is desirable that attached to the Coroner's Court there should be special medical officers, unconnected with private practice, and publicly appointed to investigate the cause of death and report it to the jury."

"That larger powers should be given to the coroner to call in a second medical opinion in any doubtful or obscure case."

"That the special officer proposed in the preceding resolution should, as soon as practicable, be the medical officer of registration proposed by Dr. Farr, and should act as the Officer of Health, who ought to be appointed in every registration district throughout the country."

"That it is the opinion of this meeting that public mortuaries ought to be erected in proper places for the prevention of the spread of infectious diseases, for the conveniences of the Coroners' courts, and for other purposes."

"That it is desirable that notice be given to the Coroner of every death that occurs in a workhouse, as of those which occur

in county lunatic asylums; and that the Coroner have power to hold inquests in all cases in which he deems inquiry necessary."

Mr. Curgenven's paper, "On the Waste of Infant Life," was read on the 18th of March, and gave a truthful but alarming picture of the loss of infant life in England. He showed that one of the most fruitful sources of death amongst infants was the practice of weaning them at an early age and feeding them by hand. This was especially the case with illegitimate offspring; if those unfortunate infants escape murder at their birth, it is only to undergo a long process of painful extinction by hand feeding. Mr. Curgenven showed that honourable marriage was no protection to the hand-fed child. At the adjourned discussion on the 13th of May, Dr. W. Farr in the chair, the following resolutions were carried:—

1. "That it is desirable for the checking of the excessive infantile mortality in manufacturing towns where women are employed, that a maternity fund be established in connection with each factory, out of which the lying-in woman should receive a sum equal to her weekly wages, and in lieu thereof, for a period of two months from the birth of her child, provided it lives, to enable her to devote the necessary maternal attention to it."

2. "That every encouragement should be given to the establishment of infant day-nurseries, where the young children of female operatives, and other working women, could be properly cared for in the absence of their mothers at work."

3. "It having been proved that very great mortality exists among illegitimate children in the care of hired nurses, a fact which shows the existence of much ignorance, carelessness, and culpable neglect on the part of these nurses, the Health Department of this Association is of opinion that protection should be accorded by the State to illegitimate children, by requiring that all persons taking charge of them should be registered, or licensed, and placed under the supervision of the Poor Law Medical officer of the district in which they reside."

During the discussion Dr. Rogers, medical officer of the Strand Union, made some valuable and practical remarks. He said, "In the treatment of weaned children under his care, he always endeavoured to provide some human milk, were it ever so little, for such children. To children under six months of age, no food should ever be given which was warmer than blood heat; warmer, in fact, than the milk when it left the mother's breast. The most complete cleanliness was also necessary with regard to the food of young children. He believed that one-half the diarrhœa, from which young children suffered was caused by keeping their food, especially their milk, in dirty vessels. It was also important that their food should be rightly compounded: a quarter of a pint of water to a pint of pure cow's milk (with a little white sugar added) was the right propor-

tion. Another point to be remembered was, that hand-fed children needed a warm temperature, to compensate for the loss of warmth which they sustained from want of constant contact with their mothers."

The public mind has been suddenly excited by the announcement that the "Black Death" had appeared in Dublin. It will be satisfactory to the public to know that from January to the present month fifty-seven cases only of a fever which has got the above name applied to it, has occurred. The symptoms are those of great prostration, with the appearance of purple or almost black spots under the skin. These are the symptoms of severe typhus, and at first this was thought to be the character of the disease. Dr. Mapother, however, the acting Medical Officer of Health for Dublin, has already carefully investigated the disease, and has come to the conclusion that, unlike typhus, it is not a communicable disease. The first cases were more sudden than those which have occurred subsequently, and the disease has been most prevalent in the most unwholesome parts of the city. Its principal symptoms in the milder cases are like those of the cerebro-spinal arachnitis which prevailed in 1866 in West Prussia. This disease was reported on by Dr. Sanderson, who was sent over by the English Government to investigate its nature, and he came to the conclusion that it was non-contagious. It is to be hoped then that in this somewhat novel disease we have no reason to fear its spreading so long as proper sanitary arrangements are enforced.

Turning now to the sanitary condition of some of our large towns, we have to report as follows:—

Manchester.—The sanitary condition of Manchester has not, during the last quarter, at all improved, nor have any effectual efforts been made by the authorities to amend it. The average death-rate has continued to be as high as that of any large town in the kingdom, and in some weeks Manchester has stood at the head of the black list. The deaths from continued fever, which in 1863 were little over 300, amounted in 1866 to 1,061, and up to the end of the first quarter of the present year they were nearly as numerous. Diarrhœa also, another certain indication of a *poisoned atmosphere*, has been almost as fatal.

The worst feature of this deplorable state of affairs is the apparent indifference of the inhabitants to the subject. The apathy they display is something marvellous. A comparatively trivial matter, such as a change ordered by the Council in the omnibus routes, has produced scores of letters to the newspapers, many indignation meetings, and heated and angry deputations to the Council. But the tale of thousands of preventable deaths, of children made orphans, of desolated homes, has appeared to fall almost unheeded on the

public ear. Are the men of Manchester so entirely devoted to money-getting that they can spare no time for these things? Is the price of cotton, or the value of railway shares so much more important than the moral and physical well-being of those by whose labour they gain their wealth, that they cannot give even a few minutes to its consideration?

Their indifference is the more remarkable because the organs of public opinion both in Manchester and London have striven to direct attention to the subject. The local press has nobly done its duty. Articles have from time to time appeared which ought to have pierced the hide of the most pachydermatous of councillors. Indications are not wanting that these attacks are at last beginning to tell. The Council have shown an approach to a suspicion that their position of passive resistance will not much longer be tenable. They have at least ceased to affect absolute indifference to what is said of them. At the annual meeting of the subscribers to the Children's Hospital, held early in April in the Mayor's parlour, with the Mayor in the chair, the medical officers to the charity ventured to present a report, in which they said that they would not have so many cases of typhus to heal, "if ordinary attention were paid to the sanitary condition of the city." The mayoral dignity was offended by this imputation on the Corporation, and his worship refused to put the motion that the report be received unless the obnoxious passage were expunged. An animated discussion ensued, in which it would be difficult to say whether more ignorance or hardihood of assertion was displayed by the defenders of the Corporation, but which ended, after the omission of the objectionable sentence, with an acknowledgment from the Mayor that the sanitary condition of the city was not in all respects what it ought to be. The subject was brought before two subsequent meetings of the city Council. The original report of the physicians to Children's Hospital was quoted, as well as the article on the Health of Manchester in our last number, and while some members of the Council strenuously denied the truth of the allegations of municipal neglect, others admitted that there was too much foundation for them. The corporate rulers of Manchester are evidently not all of one mind. By placing every member of the Council on the General Purposes Committee, by which the real business of the Corporation is transacted, and from whose discussions reporters are excluded, they have done all in their power to conceal their dissensions. Enough has, however, oozed out at the public meetings to show that they are not a happy family. It has been shown, too, that recent exposures have not been without practical effect. The attempt to enforce the payment of a tax for the removal of dry ashes, and thus to check the use of water-closets, has been at least deferred. An audacious attempt by one of the Committees to re-

open some cellar-dwellings of the filthiest and most abominable description, and which the Council had therefore ordered to be permanently closed, was at the last meeting of the Council defeated by a majority of 26 to 20. It would be well for the ratepayers at the next annual election of councillors, to look after those of the minority who shall then present themselves for re-election. This vote shows that the majority of the Council are at least unwilling to go backward in sanitary matters. If they are not at present prepared to take decided steps in a forward direction, allowance must be made for the difficulty of their position. Neglect, not altogether their own, but in part that of their predecessors in office, has permitted the causes of disease in Manchester to grow to a magnitude sufficient to appal the most courageous of sanitary reformers. Fifty thousand middens such as were described in our last number cannot be converted into water-closets, or even into dry-closets; twenty-five thousand back-to-back houses cannot be demolished and rebuilt on a more rational plan, except at an enormous cost. That cost the public mind of Manchester has probably not yet risen to the height of calmly contemplating. Pressure from the executive under, probably, a more stringent law than now exists, will have to be applied before the needful work is done.

But if the authorities are not yet prepared for vigorous action in this direction, they may at least do something to diminish the nuisances they are themselves perpetually creating. Surely the more right-feeling members of the Council cannot be conscious of the trouble, the discomfort, the absolute misery, to say nothing of the injury to health, which their servants still produce by their mode of removing the night-soil. If they wish to prove that they are really anxious to improve the health and comfort of their fellow-citizens, as well as to set them an example of cleanliness, let them order every night-soil cart to be followed by a water-cart containing a deodorizing solution, with which the foul traces of the nocturnal doings of their servants may be washed into the sewers. Let them order the men thoroughly to empty the ashpits, and cleanse them with a similar solution, instead of, as is now too often the case, picking out only the more choice and richer portions of the soil, leaving the greater part of the ashes saturated with liquid putrescent organic matter to poison the surrounding atmosphere. And let them also take steps for the early removal of the mountain of mingled excrement, slaughter-house refuse and ashes, now standing in their depôt in Water Street. And they may at least discontinue their active opposition to such measures as the Bill of Mr. M'Cullagh Torrens for the improvement of the dwellings of the working classes. To use the weighty words of a local weekly contemporary:—"The insalubrity of Manchester may proceed from causes altogether beyond their ken, but we do say that in the exceptional, and by no means

flattering position in which they stand, the Corporation would have shown more shrewdness, if not more decency, by keeping quietly in the background on this occasion."

The Corporation of Salford continue to show the superiority to their neighbours which has for some time honourably distinguished them. They have a Bill now passing through Parliament which will enable them to deal more effectually than hitherto with the many causes of disease identical with those of Manchester existing in their borough, and to appoint a Medical Officer of Health to advise them in the performance of this good work. They have recently sucessfully resisted an attempt by a powerful company to establish an abattoir and dead-meat market in a central and very populous situation, because they believed that an enormous nuisance would thereby have been occasioned. While the corporate rulers of Salford have thus been doing their duty as guardians of the health of the community, those of Manchester have quietly been permitting the erection on the bank of the Irwell, in a situation almost central to the two towns, of a piggery for several thousand pigs, and a slaughter-house in which those very cleanly and odoriferous animals are to be prepared for the pork-shops.

LIVERPOOL.—In somewhat striking contrast to the absence of sanitary proceedings in Manchester, is the unwonted activity of the officials in Liverpool. The sanitary cases are now tried by the Stipendiary, and every week scores of people are summoned either under the new Act of 1866, the Nuisance Removal Acts, or one of those numerous local Acts with which the Corporation has from time to time armed itself. Cellars, not in conformity with the Act, are closed; tenants fined for not cleansing, whitewashing, or converting the old into the new conveniences. The manufacturers, bakers, &c., are prosecuted for making an unnecessary quantity of smoke; and if the worthy magistrate would only ascertain by practical observation, better than the officials seem to know, what is an unnecessary quantity, this along with all the other sanitary reforms referred to would be a most useful movement.

About twenty thousand pounds' worth of land was bought in Liverpool about eighteen months since for labourers' dwellings, and the Corporation have not yet been able to decide upon plans, certain plans having been prepared and altered so as not to be in conformity with sanitary regulations.

The condition of Vauxhall Ward, which had obtained almost an European notoriety, is much improved, but the local authorities still refuse to comply completely with the instructions of the Home Office, in conformity with Mr. Taylor's report. Mr. B. Samuelson, M.P., has written to the Health Committee that the report will shortly be printed. We hope the honourable gentleman will see

to this, as the people of Manchester are waiting for its publication before they commence taking steps adverse to the continuance of the present system of defæcation there.

In the matter of water supply, Liverpool still stands in an unsafe position. The people of the town had been led to believe that the Corporation meant to be guided by the Royal Commission, but as recently as the 15th May they had not placed themselves in communication with the Commission, although the Liverpool water engineer, whose advice is taken by most other towns, was examined before the Commission. By the time the Liverpool people have made up their minds where to go for water, they will find every available source occupied.

A member of the Liverpool Town Council, Mr. W. Dawbarn, has published a series of pamphlets on the Sanitary Condition of Liverpool,* in one of which he reminds Dr. Trench, the medical officer, that whilst over 484,000*l.* have been expended upon sanitary works, "we are worse off in our results than before we commenced our so-called improvements." Although the author of these pamphlets is quite right in believing that it is unsafe to provide water-closets without ensuring a sufficient supply of water, yet we think the pressure should be brought to bear, not upon those who are doing their part of the work of conversion, but upon those others who neglect to provide the necessary and proper auxiliary, the supply of water.

A large amount of angry and bitter recrimination is introduced into these discussions, and the Liverpool Sanitary Association, who, to use an expressive simile of Dr. Trench, have "been blowing the bellows" for the Corporation for some time past, have fallen in for a larger share of odium and abuse than usually rewards the efforts of those who seek to benefit the community. Such cries of pain, however, always accompany the operations which are necessitated by the long neglect of dangerous sores, and whilst Corporations must learn to bear and be thankful even for the sharp incision of the knife, or the suffering which accompanies the healing process; so, too, should the operators be prepared for a good deal of noise and ingratitude on the part of their patients.

Two new parks are being prepared for the townspeople. One on which much money is likely to be lavished is at the south end, and is said to be intended to protect the grand folks from the intrusion of the commonalty. The other, Stanley Park, is at the extreme north, and although it at present consists of a number of fields only, it affords a splendid recreation-ground for the poor who reside in the crowded and unhealthy wards.

Taking all in all, therefore, there is much to praise, even if

* 'The Sanitary Condition of Liverpool.' By William Dawbarn. Liverpool: J. Woollard.

there be much to blame, in the action of the local authorities of Liverpool; and we hope to be able, in our next, to report further progress.

LEEDS.—Those who for some years past have been endeavouring to rouse the custodians of the public health in Leeds to a sense of their responsible duty, may at last congratulate themselves that their efforts have not been without effect in the right direction, and that the local authority has recently given a little more attention to the sanitary requirements of the town, which has been followed by a diminution of the death-roll.

The officer of health has been invested with a little more of that independent power of action which many think it desirable that he should possess, and a staff of assistants has been placed at his disposal to systematically inspect and report upon the various matters brought to their notice.

The disinfection of houses where diseases of a contagious nature have had their habitat is strictly enforced, and, with a view to suppressing overcrowding, houses wherein lodgers are taken are registered by the medical officer under the powers of the Sanitary Act; these houses, although not included amongst the class of common lodging-houses, are subject to similar rules and surveillance.

Within the last twelve months many miles of main sewers and drains have been laid down, and the work of levelling, flagging, and paving new streets progresses in a satisfactory manner. With this awakening to activity it is no matter of surprise that typhus fever and other diseases of a zymotic character should decrease, as the following table (which is a summary of all deaths from zymotics during the quarter ending May 26, 1866, and May 25, 1867), shows to be the case:—

Quarter ending May 26, 1866.		*Quarter ending May* 25, 1867.	
Small-pox	19	Small-pox	13
Measles	62	Measles	6
Scarlatina	23	Scarlatina	20
Hooping-cough	80	Hooping-cough	52
Croup	26	Croup	19
Diarrhœa	34	Diarrhœa	21
Dysentery	3	Dysentery	2
Typhus	162	Typhus	50
Erysipelas	6	Erysipelas	3
Syphilis	3	Syphilis	2
Diphtheria	6	Diphtheria	8
Quinsy	3	Quinsy	1
Total	427	Total	197

The total number of deaths registered in the borough of Leeds during the thirteen weeks ending May 28, 1867, was 1,557, against 2113, the number that occurred during the corresponding period last year.

The deaths during the above quarter of the present year were at the rate of 26·7 per 1,000 per annum, against 36·8, the rate that prevailed during the relative time last year.

This recent improvement although most marked during, was not confined to, last quarter, for the first ordinary quarter of the present year ending March 30th presented also a favourable contrast to the corresponding quarters of 1865 and 1866. The number of deaths registered during the first quarters of 1865, 1866, and 1867, being respectively 1,788, 2,095, and 1,700.

The above result furnishes a strong argument for earnest sanitarians to persevere in the good work of endeavouring to prevent unnecessary disease and death, and still vigilantly to guard the watch-tower from which public opinion makes itself felt and heard, for it would be idle to suppose that the foregoing description of some of the work achieved in Leeds is anything beyond the mere commencement of effort to be pursued in a large field of labour, and it must not be forgotten that the public mind still requires educating on common sanitary laws, and that the public attention still needs directing to the importance of building model houses for the poor, public abattoirs, mortuaries, &c.

DUNKELD.—Most of our readers will have tarried at this interesting town, who have passed it on their way to the Eastern Highlands of Scotland, and little would they dream that a spot so highly favoured by nature, should be so utterly degraded by man, as it would appear to be from the following extracts from a paper read by Dr. John Adamson, of St. Andrew's, before the Philosophical Institute of that city:—

"Dunkeld," he says, "is a town of Perthshire, situated on the north bank of the Tay, in the corner of an irregular natural amphitheatre, surrounded by hills varying in height from 1,000 to 1,500 feet. When this open space among the hills is estimated by the eye, it appears to be less than two miles at its greatest length, by half-a-mile in breadth; and viewed pictorially, it doubtless is a beautiful site for a small town. It is luxuriant with vegetation, and studded with wooded knolls and handsome villas, growing into a second town near the railway station. The river Tay passes through it, with grassy flats and fine old trees upon its banks; while the whole is enclosed within a background of woods and rocks and heather, rising high around it on picturesque-looking hills. The miniature town, too, when looked at in the same merely pictorial light from the middle of the bridge, or from the opposite river bank, is not unworthy of its site. It is a cluster of white-walled, blue-slated houses, nestled among trees beside its old cathedral church; and with the wooded hills behind, and the broad river flowing towards it through the green lawns and the graceful foliage of the Athole grounds, it exhibits, in a single view, a combination of scenic beauties in their kind which can rarely be equalled.

"But this town has another aspect in which there is no beauty. It is situated upon a level space of small area, between the river and a wooded hill, with trees encroaching upon the houses. The space towards the river is divided into back courts and narrow gardens, by walls and hedges. Streets stand at right angles to each other; and a few houses of more than one storey in height, are crowded into lanes and courts behind the streets. Drainage to the river is only partial; wells within the town indicate the absence of natural drainage; while the surface,

composed of sandy gravel, is absorbent of fluids. Refuse of men and animals is allowed to accumulate within the town, in large offensive dunghills. In the warm month of September, pigs might be seen standing knee-deep in their own dung. Dirty liquids were stagnating in the sun in some of the narrow back courts, with other foul accumulations unnameable—nuisances alike to sight and smell.

"The air in Dunkeld is thus seen to be limited in extent, in consequence of the small area surface occupied by houses; and, in consequence of its sheltered site, the streets are screened from the wholesome breezes enjoyed by exposed towns. The ventilation of individual houses is impeded by the plan of the streets, and by trees; and while such a combination of impediments to free circulation and renewal of the air demands every precaution possible to preserve its purity, a want of proper police regulations permits slovenly dirty people to pollute it for themselves and their neighbours, by habits which, without exaggeration of language, may be termed a disgrace to a civilized society.

"In 1851 and 1861 the census returns for the Dunkeld district gave 1,141 and 1,080 as the numbers of the population in these years; and the total deaths, within the district from 1855 to 1861, a period of seven years, were 195, or 28 yearly—numbers which are equivalent to a death rate of 25·5 for the district.

"The inhabitants of the town, according to a competent local authority, were about 1,000 in 1851, but in 1861 this number had diminished to 926, while the deaths from 1855 to 1865, inclusive, were 265, or 24 1-11th yearly. If 950 be assumed as an average population for the eleven years—and it probably is above the actual number—the death rate for the town alone cannot be less than 25·5. It is 9·1 in excess of the rate in Grantown,* where the annual deaths among 1,500 living are actually fewer than among a thousand in Dunkeld; and it exhibits the strange and melancholy spectacle of a small agricultural community, occupying a beautiful Highland valley, who are not more healthy than if they were confined to the dingy courts and lanes of a large town."

If the author of the paper from which these extracts are made would add another obligation to that which he has conferred upon society, by publishing these facts, he would do well. Let him draw the attention of some spirited inhabitant of Dunkeld to the 49th Section of the Sanitary Act of 1866, and recommend him to forward a complaint of the disgraceful condition of the little place to the Home Office; we think we may safely predict that a visit from the Government Inspector would soon reduce the death rate.

* The author was comparing Dunkeld with Grantown in his paper.

Quarterly List of Publications received for Review.

1. The Elements of Natural Philosophy ; or, an Introduction to the Study of the Physical Sciences. By Charles Brooke, M.A., F.R.S. Based on the Treatise by the late Dr. Golding Bird. Sixth Edition. 880 pp. Fcap. 8vo. 701 *Wood Engravings.* *John Churchill & Sons.*

2. Hospitals, Infirmaries, and Dispensaries: their Construction, Interior Arrangement, and Management, with Descriptions of existing Institutions and Remarks on the present System of affording Relief to the Sick Poor. By F. Oppert, M.D., L.R.C.P.L., Physician to the City Dispensary. 230 pp. Roy. 8vo. 58 *Wood Engravings.* *John Churchill & Sons.*

3. A Dictionary of Science, Literature, and Art. New edition by W. T. Brande, D.C.L., F.R.S., and Rev. Geo. W. Cox, M.A. 3 vols. 8vo. *Longmans & Co.*

4. Blind People: their Works and Ways ; with Sketches of the Lives of some famous Blind Men. By Rev. B. G. Johns, M.A., Chaplain of the Blind School, St. George's Fields. *With Engravings.* 200 pp. Post 8vo. *John Murray.*

5. Light: its Influence on Life and Health. By Forbes Winslow, M.D., D.C.L. Oxon. (Hon.), &c. *Longmans & Co.*

6. The North-west Peninsula of Iceland: being the Journal of a Tour in Iceland in the Spring and Summer of 1862. By C. W. Shepherd, M.A., F.Z.S. 170 pp. Crown 8vo. *Longmans & Co.*

7. The Electric Telegraph. By Dr. Lardner. A new edition by Edw. B. Bright, F.R.A.S., Secretary of the British and Irish Magnetic Telegraph Company. 140 *Engravings.* 280 pp. Post 8vo. *James Walton.*

8. Handbook of Astronomy. By Dionysius Lardner, D.C.L. Third edition by Edwin Dunkin, F.R.A.S., Superintendent of the Altazimuth Department, Royal Observatory, Greenwich. 38 *Plates and* 109 *Wood Engravings.* 550 pp. Post 8vo. *James Walton.*

9. Memoirs, Annual Report, and Catalogues of the Geological Survey of India. *Calcutta.*

10. Transactions of the American Institute, New York.

11. Observations on the Genus Unio, &c., &c. By Isaac Lea, LL.D. 24 *Plates.* Roy. 4to. Vol. XI. *From the Author.*

12. Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartêt and Henry Christy. Edited by Thomas Rupert Jones, Professor of Geology, Royal Military College, Sandhurst. Part IV.
From the Executors of the late Henry Christy, Esq.

PAMPHLETS, PERIODICALS, AND PROCEEDINGS OF SOCIETIES.

Sesion Pública Aniversario vigésimo-septimo del Instituto Médico Valenciano. *Valencia.*

Geology and Agriculture. By E. St. John Fairman, F.G.S. 8 pp. 8vo. *Florence.*

The Poisons of the Spreading Diseases. By Benjamin W. Richardson, M.D., F.R.C.P. 27 pp. 8vo. *J. Churchill & Sons.*

A Sheet of Instructions for the Prompt Treatment of Accidents and Emergencies. By A. Smee, F.R.S.

On the Encroachment of the Sea between the River Mersey and the Bristol Channel. Prize Essay. By J. F. Thomas, F.G.S. 20 pp. 8vo. *E. & F. N. Spon.*

Christianity and Rationalism in their Relations to Natural Science: being a Protest against certain Principles advocated in Mr. Lecky's History of the Rise and Influence of the Spirit of Rationalism in Europe. By Charles Daubeny, M.D., F.R.S., Professor of Botany in the University of Oxford. 24 pp. Demy 8vo. *James Parker & Co.*

Meteorological Observations on the Humidity of the Air of Scarborough, with Chapters on Rain, Rain Gauges, and Rainfall Investigations, and on the Humidity of the Atmosphere in Relation to Disease. By Cornelius B. Fox, M.D., M.R.C.P. Lond. 50 pp. Crown 8vo. *Simpkin & Co*

Experimental Investigations connected with the Supply of Water from the Hooghly to Calcutta. By David Waldie, F.C.S. 32 pp. 8vo.

On the Development and Succession of the Teeth in the Marsupialia. By William Henry Flower, F.R.S. 4 pp. 8vo.

Germinal Matter and the Contact Theory. By James Morris, M.D. Lond. 20 pp. Demy 8vo. *John Churchill & Sons.*

Clinical Lectures (illustrated by Coloured Photographs from Life) on the Diseases of the Skin. By B. Squire, M.B., F.L.S. Nos. 1 & 2. *John Churchill & Sons.*

Household Manuals. Good Food: What it is, and How to get it. By Edwin Lankester, M.D., F.R.S. *Routledge & Sons.*

An Explanation of the Popular Weather Prognostics of Scotland, on Scientific Principles. By the Rev. Charles Clouston. *Edinburgh: A. & C. Black.*

A new Chemical Nomenclature. By S. D. Tillman, A.M. *Albany: C. van Benthuysen & Sons.*

On the Distribution of Temperature in the Lower Region of the Earth's Atmosphere. By Henry Hennessy, F.R.S. *Dublin: M. H. Gill.*

On the Social Statistics of certain Boroughs and Townships in Lancashire and Cheshire during the last Twenty Years. By Henry Carne Oats, LL.B. *Manchester.*

The Doctrine of the Correlation of Forces: its Development and Evidence. By the Rev. James Cranbrook. *Edinburgh: Edmonston.*

A Comparison of the Death Rates of Grantown and Dunkeld. By John Adamson, M.D.

A New Theory of the Cause of Tides. By John Cuthbertson. *Glasgow: Murray & Son.*

On the Function of the Blood in Muscular Work. By C. W. Heaton, F.C.S.

Intercolonial Exhibition, 1866. Mining and Mineral Statistics. By R. Brough Smyth, F.G.S. *Melbourne: Blundell & Ford.*

Readwin's Index to Mineralogy. By T. A. Readwin, F.G.S. *London: Spon.*

The Westminster Review.

The American Naturalist (a popular Illustrated Magazine of Natural History). Salem. Essex Institute. *London: Trübner.*

Revue Universelle des Mines, &c. *Paris and Liege.*

Bulletin Mensuel de la Société Impériale d'Acclimatation. *Paris.*

The Geological Magazine. *Trübner & Co.*

Le Mouvement Médical, Journal de la Santé publique.

The Canadian Naturalist and Geologist. *Montreal: Dawson Bros.*

The Scientific Journal. *Philadelphia.*

The Naturalist's Circular, Medium of Exchange and Amateur's Reporter, in Natural History, Geology, and Microscopy. June, 1867.

Journal of the Academy of Natural Sciences of Philadelphia. New Series. Vol. VI. Part 1.

Proceedings of the Academy of Natural Sciences of Philadelphia for the year 1866.

The President's Address and Reports for 1866, together with Rules, List of Members, and Catalogue of Books, of the West Kent Natural History, Microscopical, and Photographic Society. 20 pp. Fcap. 8vo.

The Proceedings of the Cotteswold Naturalists' Field Club for 1865. 74 pp. Royal 8vo.

Introductory Address at the Public Opening of the Medical Session 1866-67, in the University of Glasgow. By W. T. Gairdner, M.D., Professor of Practice of Physic in the University. 20 pp. 8vo. *Maclehose, Glasgow.*

Proceedings of the Bath Natural History and Antiquarian Field Club.

Proceedings of the Royal Institution of Great Britain.

" " Royal Society.
" " Royal Astronomical Society.
" " Royal Geographical Society.
" " Chemical Society.
" " Geological Society.
" " Zoological Society.

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